DX 104

PATENT APPLICATION

09573081

10759 U.S. PTO
09/573081
05/16/00

INITIALS 6/...

CONTENTS

		Date Received (Incl. C. of M.) or Date Mailed			Date Received (Incl. C. of M.) or Date Mailed
1.	Application 9 papers.		42.		
	11-15-00 Prel. amdt. A	5-16-00	43.		
	11-15-00 IDS	5-16-00	44.		
	PTO-37	12-13-00	45.		
	Formal Drawings (9 shts) set 1	1-13-01	46.		
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Case No. 04-1371-JJF
DEFT Exhibit No. DX 104
Date Entered ______________
Signature ______________

PATENT NUMBER
6229366

U.S. UTILITY Patent Application

O.I.P.E. PATENT DATE
MAY 08 2001

APPLICATION NO.	CONT/PRIOR	CLASS	SUBCLASS	ART UNIT	EXAMINER
09/573081	D	327	172	2816	Zweizig

APPLICANTS
Balu Balakirshnan
Alex Djenguerian
Leif Lund

TITLE
Off-line converter with integrated softstart and frequency jitter

ISSUING CLASSIFICATION

ORIGINAL CLASS	ORIGINAL SUBCLASS	CROSS REFERENCE(S) CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					
327	172	327	148	531	544			

INTERNATIONAL CLASSIFICATION
H03K 3/0171

☐ Continued on Issue Slip Inside File Jacket

☐ TERMINAL DISCLAIMER	DRAWINGS Sheets Drwg.	Figs. Drwg.	Print Fig.	CLAIMS ALLOWED Total Claims	Print Claim for O.G.
	9	9	3	18	1

☐ The term of this patent subsequent to _____ (date) has been disclaimed.

☐ The term of this patent shall not extend beyond the expiration date of U.S. Patent No. _____

☐ The terminal ___ months of this patent have been disclaimed.

JEFFREY ZWEIZIG
PRIMARY EXAMINER
4/17/02 (Date)

NOTICE OF ALLOWANCE MAILED
12-13-00

ISSUE FEE

Amount Due	Date Paid
$1,250.00	3/15/01

ISSUE BATCH NUMBER
W31

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The information disclosed herein may be restricted. Unauthorized disclosure may be prohibited by the United States Code Title 35, Sections 122, 181 and 368. Possession outside the U.S. Patent & Trademark Office is restricted to authorized employees and contractors only.

Form PTO-436A (Rev. 6/00)

FILED WITH: ☐ DISK (CRF) ☐ FICHE ☐ CD-ROM
(Attention is posted on right inside flap)

ISSUE FEE IN FILE

Formal Drawings ☐ Yes ☐ No

(FACE)

file://c:/APPS/process/correspondence/1.htm

[redacted]
Filing Data Sheet

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/573,051	05/16/2000 RULE	327	2816	003692.P036D

APPLICANTS
Balu Balakrishnan, Saratoga, CA;
Alex Djenguerian, Saratoga, CA;
Leif Lund, San Jose, CA;

** CONTINUING DATA **********
JZ THIS APPLICATION IS A DIV OF 09/080,774 05/18/1998, now USPN 6,107,851

** FOREIGN APPLICATIONS **********
JZ none

IF REQUIRED, FOREIGN FILING LICENSE GRANTED
** 07/19/2000

Foreign Priority claimed	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
35 USC 119 (a-d) conditions met ☐ yes ☒ no ☐ Met after Allowance	CA	9	18	2
Verified and Acknowledged Examiner's Signature (initials) JZ				

ADDRESS
James Y Go
Blakely Sokoloff Taylor & Zafman LLP
12400 Wilshire Boulevard
Seventh Floor
Los Angeles, CA 90025-1026

TITLE
Off-line converter with integrated softstart and frequency jitter

FILING FEE RECEIVED	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:	
690		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other ☐ Credit

7/19/00 11:23 AM

05-18-00

Please type a plus sign (+) inside this box [+]

PTO/SB/05 (12/97)
Approved for use through 09/30/00. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

UTILITY PATENT APPLICATION TRANSMITTAL
(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No. 003892.P036D Total Pages 2

First Named Inventor or Application Identifier Babu Balakrishnan

Express Mail Label No. EL414999069US

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, D. C. 20231

APPLICATION ELEMENTS
See MPEP chapter 600 concerning utility patent application contents.

1. X Fee Transmittal Form
(Submit an original, and a duplicate for fee processing)

2. X Specification (Total Pages 33)
(preferred arrangement set forth below)
- Descriptive Title of the Invention
- Cross References to Related Applications
- Statement Regarding Fed sponsored R & D
- Reference to Microfiche Appendix
- Background of the Invention
- Brief Summary of the Invention
- Brief Description of the Drawings (if filed)
- Detailed Description
- Claims
- Abstract of the Disclosure

3. X Drawings(s) (35 USC 113) (Total Sheets 9)

4. X Oath or Declaration (Total Pages 3)
   a. ___ Newly Executed (Original or Copy)
   b. XX Copy from a Prior Application (37 CFR 1.63(d))
   (for Continuation/Divisional with Box 17 completed) (Note Box 5 below)
   i. ___ DELETIONS OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).

5. XX Incorporation By Reference (useable if Box 4b is checked)
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

6. ___ Microfiche Computer Program (Appendix)

FCS0000229

09857301.052501

7. ___ Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)
a. ___ Computer Readable Copy
b. ___ Paper Copy (identical to computer copy)
c. ___ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. ___ Assignment Papers (cover sheet & documents(s))
9. ___ a. 37 CFR 3.73(b) Statement (where there is an assignee)
___ b. Power of Attorney
10. ___ English Translation Document (if applicable)
11. X a. Information Disclosure Statement (IDS)/PTO-1449
X b. Copies of IDS Citations
12. X Preliminary Amendment
13. X Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
14. ___ a. Small Entity Statement(s)
b. Statement filed in prior application, Status still proper and desired
15. ___ Certified Copy of Priority Document(s) (if foreign priority is claimed)
16. X Other: separate sheet with title, express mail label, copy of postcard and attorney's signature
77 cited references

17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:
___ Continuation XX Divisional ___ Continuation-in-part (CIP)
of prior application No: 09/080,774

18. Correspondence Address
___ Customer Number or Bar Code Label ______ (Insert Customer No. or Attach Bar Code Label here)
or
X Correspondence Address Below

NAME James Y. Go
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
ADDRESS 12400 Wilshire Boulevard
Seventh Floor
CITY Los Angeles STATE California ZIP CODE 90025-1026
Country U.S.A. TELEPHONE (425) 827-8600 FAX (425) 827-5844
Express Mail Label: EL414990086US

Approved for use through 09/30/00. OMB 0651-0032.
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PTO/SB/17 (8/98)
Approved for use through 08/30/2000. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

FEE TRANSMITTAL FOR FY 2000

TOTAL AMOUNT OF PAYMENT ($) 690.00

Complete if Known:
Application No. New Application
Filing Date Herewith
First Named Inventor Balu Balakrishnan
Group Art Unit
Examiner Name
Attorney Docket No. 019592.P036D

METHOD OF PAYMENT (check one)

1. [X] The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:
Deposit Account Number 02-2666
Deposit Account Name
[X] Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17

2. X Payment Enclosed:
X Check
Money Order
Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	690	201	345	Utility application filing fee	690.00
106	310	206	155	Design application filing fee	
107	480	207	240	Plant filing fee	
108	690	208	345	Reissue filing fee	
114	150	214	75	Provisional application filing fee	

SUBTOTAL (1) $ 690.00

2. EXTRA CLAIM FEES

	Extra Claims		Fee from below		Fee Paid
Total Claims 18	- 20** =	0	X	=	
Independent Claims 2	- 3** =	0	X	=	
Multiple Dependent				=	

**Or number previously paid, if greater; For Reissues, see below.

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	78	202	39	Independent claims in excess of 3
104	260	204	130	Multiple dependent claim, if not paid
109	78	209	39	**Reissue independent claims over original patent
110	18	210	9	**Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) $ 00.00

FEE CALCULATION (continued)

Patent fees are subject to annual revisions. Small Entity payments must be supported by a small entity statement, otherwise large entity fees must be paid.
See Forms PTO/SB/09-12

05/16/00

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for response within first month	
116	380	216	190	Extension for response within second month	
117	870	217	435	Extension for response within third month	
118	1,360	218	680	Extension for response within fourth month	
128	1,850	228	925	Extension for response within fifth month	
119	300	219	150	Notice of Appeal	
120	300	220	150	Filing a brief in support of an appeal	
121	260	221	130	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive unavoidably abandoned application	
141	1,210	241	605	Petition to revive unintentionally abandoned application	
142	1,210	242	605	Utility issue fee (or reissue)	
143	430	243	215	Design issue fee	
144	580	244	290	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	750	246	360	For filing a submission after final rejection (see 37 CFR 1.129(a))	
149	750	249	360	For each additional invention to be examined (see 37 CFR 1.129(a))	
Other fee (specify)					
Other fee (specify)					

SUBTOTAL (3) * $ 00.00

*Reduced by Basic Filing Fee Paid

SUBMITTED BY:

Typed or Printed Name: James Y. Go

Signature _____ Date 5-16-00

Reg. Number 40,621 Deposit Account User ID _____ (complete if applicable)

Our Reference: 003692.P036D

Patent U.S. PTO
05/16/00

OFF-LINE CONVERTER WITH INTEGRATED SOFTSTART AND FREQUENCY JITTER

Inventors: Balu Balakrishnan, Alex Djenguerian and Leif Lund

Respectfully submitted,

BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP

James Y. Go
Reg. No. 40,821

"Express Mail" mailing label number: EL414999018US
Date of Deposit: May 16, 2000
I hereby certify that I am causing this paper or fee to be deposited with the United States Postal Service "Express Mail Post Office to Addressee" service on the date indicated above and that this paper or fee has been addressed to the Assistant Commissioner for Patents, Washington, D. C. 20231

Melanie Ramacher
(Typed or printed name of person mailing paper or fee)

Melanie Ramacher 5-16-00
(Signature of person mailing paper or fee) (Date signed)

Serial/Patent No.: New Application
Client: Power Integrations, Inc.
Title: OFF-LINE CONVERTER WITH INTEGRATED SOFTSTART AND FREQUENCY JITTER
BSTZ File No.: 003692.P036D
Date Mailed: May 16, 2000
Filing/Issue Date: Herewith
Atty/Secy Initials: JYG/mmh
Docket Due Date:

The following has been received in the U.S. Patent & Trademark Office on the date stamped hereon:

- [x] Express Mail No. EL414999018US
- [x] Check No. 10085 Amt 1000.00
- [x] Check No. Amt
- [x] Other: Copy of 77 cited references

FCS0000233

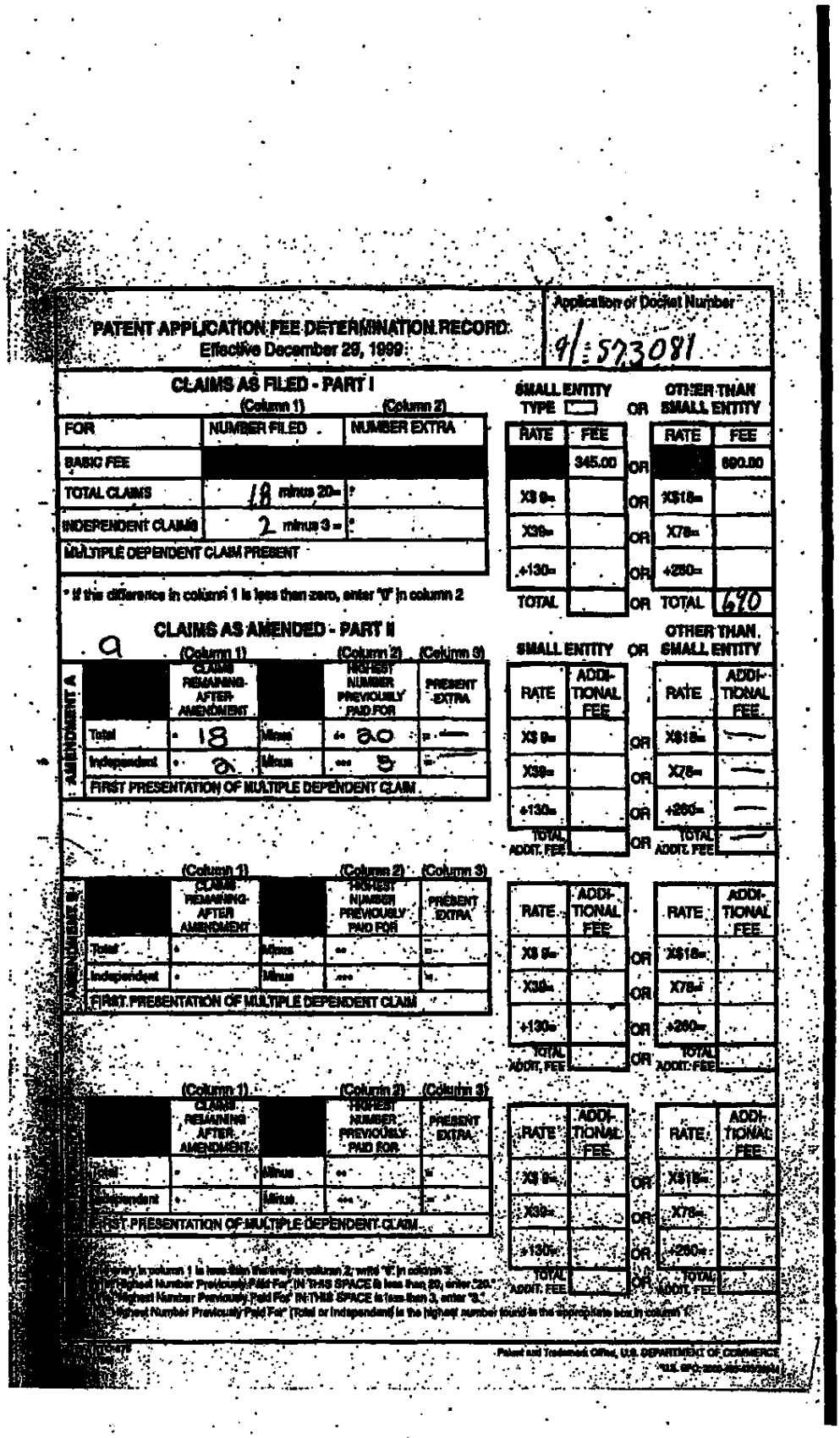
PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

05/25/2000 PHUNGNC 00000001 05573081
01 FC:101 150.00 OP

PTO-1556
(5/87)

*U.S. GPO: 1998-438-062/49144



PATENT APPLICATION FEE DETERMINATION RECORD
Effective December 29, 1999

Application or Docket Number 9/573081

CLAIMS AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA
BASIC FEE		
TOTAL CLAIMS	18 minus 20=	*
INDEPENDENT CLAIMS	2 minus 3 =	*
MULTIPLE DEPENDENT CLAIM PRESENT		

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE	RATE	FEE	OR	OTHER THAN SMALL ENTITY RATE	FEE
		345.00	OR		690.00
X$ 9=			OR	X$18=	
X39=			OR	X78=	
+130=			OR	+260=	
TOTAL			OR	TOTAL	690

CLAIMS AS AMENDED - PART II

AMENDMENT A	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 18	Minus	** 20	= —
Independent	* 0	Minus	*** 3	= —
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	—
X39=		OR	X78=	—
+130=		OR	+260=	—
TOTAL ADDT. FEE		OR	TOTAL ADDT. FEE	—

AMENDMENT B	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X39=		OR	X78=	
+130=		OR	+260=	
TOTAL ADDT. FEE		OR	TOTAL ADDT. FEE	

AMENDMENT C	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X39=		OR	X78=	
+130=		OR	+260=	
TOTAL ADDT. FEE		OR	TOTAL ADDT. FEE	

* If entry in column 1 is less than entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

ISSUE SLIP STAPLE AREA (for additional cross references)

POSITION	INITIALS	ID NO.	DATE
FEE DETERMINATION	PS	66621	5/25
O.I.P.E. CLASSIFIER		4/9	6/1/05
FORMALITY REVIEW	E.R.L.	70622	7/15-05
RESPONSE FORMALITY REVIEW			

INDEX OF CLAIMS

✔ ..... Rejected
= ..... Allowed
– (Through numeral)... Canceled
÷ ..... Restricted
N ..... Non-elected
I ..... Interference
A ..... Appeal
O ..... Objected

Claim	Date	Final	Original
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If more than 150 claims or 10 actions staple additional sheet here

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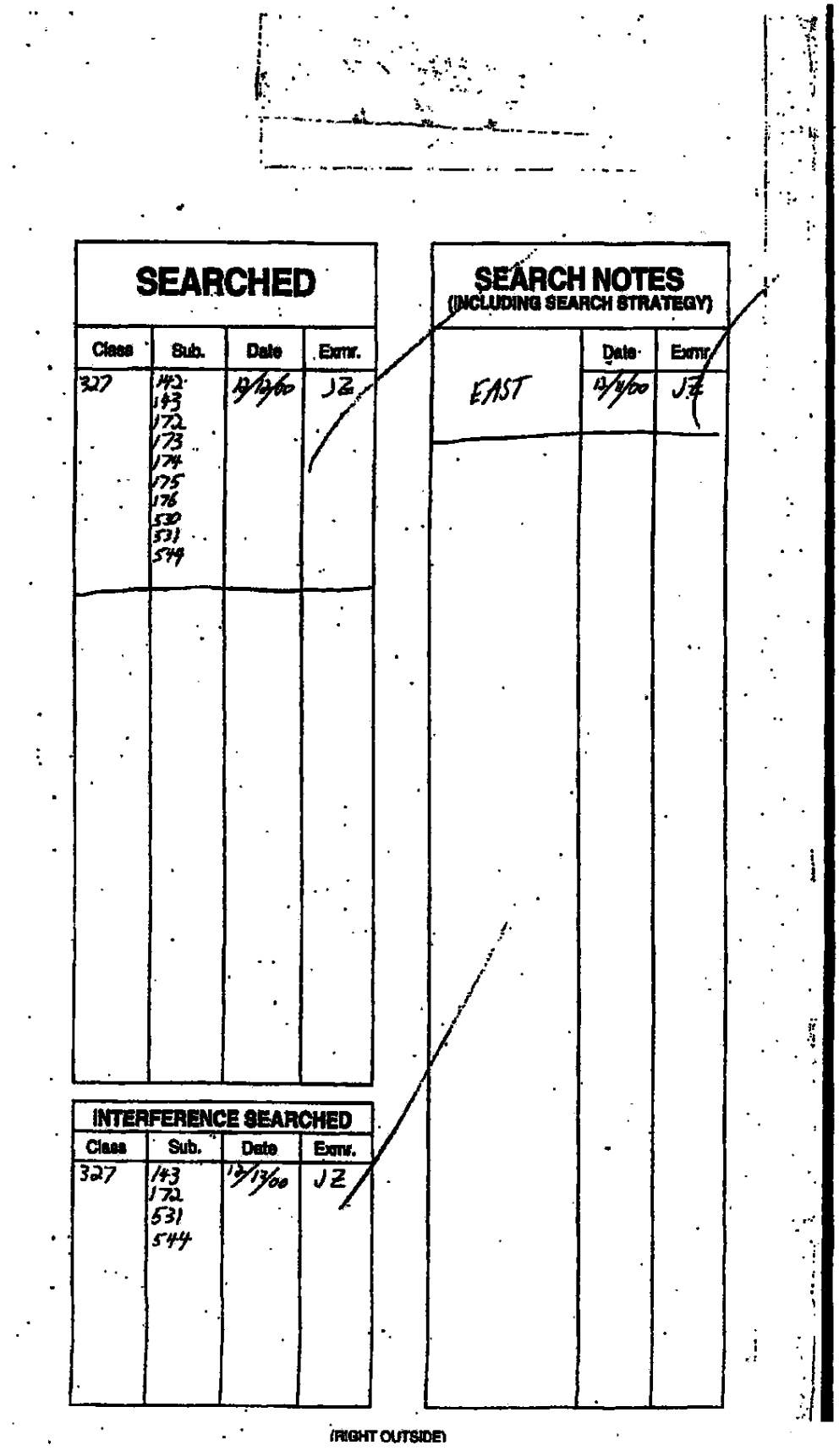

SEARCHED

Class	Sub.	Date	Exmr.
327	142 143 172 173 174 175 176 530 531 544	12/13/00	JZ

SEARCH NOTES
(INCLUDING SEARCH STRATEGY)

	Date	Exmr.
EAST	12/4/00	JZ

INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.
327	143 172 531 544	12/13/00	JZ

(RIGHT OUTSIDE)

08573084-051600

233/248
PATENT

SPECIFICATION

TITLE OF THE INVENTION

OFFLINE CONVERTER WITH INTEGRATED SOFTSTART AND FREQUENCY JITTER

BACKGROUND

Field Of The Invention

The field of the present invention pertains to the field of power supplies and among other things to the regulation of power supplies.

Background Of The Invention

Power supplies that convert an AC mains voltage to a DC voltage for use by integrated electronic devices, amongst other devices, are known. The power supplies are required to maintain the output voltage, current or power within a regulated range for efficient and safe operation of the electronic device. Switches that operate according a pulse width modulated control to maintain the output voltage, current, or power of the power supply within a regulated range are also known. These switches utilize an oscillator and related circuitry to vary the switching frequency of operation of the switch, and therefore regulated the power, current or voltage that is supplied by the power supply.

A problem with utilizing pulse width modulated switches is that they operate at a relatively high frequency compared to the frequency of the AC mains voltage, which results in a high frequency signal being generated by the power supply. This high frequency signal is injected back into the AC mains input and becomes a component of the AC mains signal. The

Express Mail No. EM563810348US
Docket No: 233/248
May 18, 1998

high frequency signals are also radiated by the power supply as electromagnetic waves. These high frequency signals add to the Electromagnetic Interference (EMI) of the power supply, and in fact are the largest contributors to the EMI of the power supply. The EMI generated by the power supply can cause problems for communications devices in the vicinity of the power supply and the high frequency signal which becomes a component of the AC mains signal will be provided to other devices in the power grid which also causes noise problems for those devices. Further, the radiated EMI by the power supply can interfere with radio and television transmissions that are transmitted over the air by various entities.

To combat the problem of EMI, several specifications have been developed by the Federal Communications Commission (FCC) in the United States and the European Community (EC) have established specification that specify the maximum amount of EMI that can be produced by classes of electronic devices. Since power supplies generate a major component of the EMI for electronic devices, an important step in designing a power supply is minimizing the EMI provided by the power supply to levels with the acceptable limits of the various standards. Since, a power supply can be utilized in many different countries of the world, the EMI produced should be within the most stringent limits worldwide to allow for maximum utilization of the power supply.

A known way of minimizing the EMI provided by the power supply is by adding an EMI filter to the input of the power supply. An EMI filter generally utilizes at least one inductor, capacitor and resistor in combination. However, the greater EMI produced by the power supply, the larger the components that are utilized as part of the EMI filter. The cost of the EMI filter is in large part determined by the size of the inductor and capacitor utilized. The longer the

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components, the higher the cost of the power supply. Further, simply utilizing an EMI filter does not address the radiated EMI.

Another problem associated with pulse width modulated switches results from operation of the power supply at start up. At start up, the voltage, current and power at the output of the power supply will essentially be zero. The pulse width modulated switch will then conduct for the maximum possible amount of time in each cycle of operation. The result of this is a maximum inrush current into the power supply. The maximum inrush current is greater than the current that is utilized during normal operation of the power supply. The maximum inrush current stresses the components of power supply and switch. Stress is specifically a problem for the switch, or transistor, the transformer of the power supply, and the secondary side components of the power supply. The stress caused by the maximum inrush current decreases the overall life of the power supply and increases the cost of the power supply because the maximum rating of the components used in the power supply to not destruct from the inrush currents will be greater than the maximum rating required for normal operation.

Further, when the pulse width modulated switch conducts for the maximum possible amount of time in each cycle of operation the voltage, current and power at the output of the power supply rise rapidly. Since the feedback circuit of the power supply often does not respond as fast as the operating frequency of the switch, the rapid rise of the voltage, current and power will often result in an overshoot of the maximum voltage in the regulation range which will cause damage to the device being supplied power by the power supply.

Referring to Fig. 1 a known power supply that attempts to minimize EMI and reduce startup stress is depicted. A rectifier 10 rectifies the filtered AC mains voltage 5, from EMI filter 120, input by the AC mains to generate a rectified voltage 15. Power supply capacitor 20 then

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generates a substantially DC voltage with a ripple component. The rectified voltage 15 with ripple component is provided to the primary winding 35 of transformer 40 that is used to provide power to secondary winding 45. The output of secondary winding 45 is provided to secondary rectifier 50 and secondary capacitor 55 that provide a secondary DC voltage 60 at the power supply output 65 to the device that is coupled to the power supply.

In order to maintain the secondary DC voltage within a regulate range a feedback loop including an optocoupler 70, zener diode 75 and a feedback resistor 80 provides a signal indicative of the voltage at the power supply output 65 to feedback pin 85 of pulse width modulated switch 90. The voltage magnitude at the feedback terminal is utilized to vary the duty cycle of a switch coupled between the drain terminal 95 and common terminal 100 of the pulse width modulated switch 90. By varying the duty cycle of the switch the average current flowing through the primary winding and therefore the energy stored by the transformer 40 which in turn controls the power supplied to the power supply output 65 is kept within the regulated range. A compensation circuit 105 is coupled to the feedback pin 85 in order to lower the bandwidth of the frequency of operation of the pulse width modulator.

Inrush currents are minimized at start up by use of soft start capacitor 110. Soft start functionality is termed to be a functionality that reduces the inrush currents at start up. At this instant a current begins to flow through feedback resistor 80 and thereby into soft start capacitor 110. As the voltage of soft start capacitor 110 increases slowly, current will flow through light emitting diode 115 of optocoupler 70 thereby controlling the duty cycle of the switch. Once the voltage of the soft start capacitor 110 reaches the reverse breakdown voltage of zener diode 75 current will flow through zener diode 75. The approach described above will reduce the inrush currents into the power supply, however, it will be several cycles before the light emitting diode

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115 will begin conducting. During the several cycles the maximum inrush current will still flow through the primary winding and other secondary side components. During these cycles the transformer may saturate, and therefore the transformer may have to be designed utilizing a higher core size than would be required for normal operation even with the use of soft start capacitor as in Fig. 1.

To reduce the EMI output by the power supply an EMI filter 120 is utilized. Additionally, pulse width modulated switch 90 is equipped with frequency oscillation terminals 125 and 130. Frequency oscillation terminal 125 and 130 receive a jitter current 135 that varies according to the ripple component of substantially DC voltage 25. The jitter current 135 is used to vary the frequency of the saw-toothed waveform generated by the oscillator contained in the pulse width modulated switch 90. The saw toothed waveform generated by the oscillator is compared to the feedback provided at the feedback pin 85. As the frequency of the saw toothed waveform varies, so will the switching frequency of the switch coupled between the drain and common terminal. This allows the switching frequency of the switch to be spread over a larger bandwidth, which minimizes the peak value of the EMI generated by the power supply at each frequency. By reducing the EMI the ability to comply with government standards is increased, because the government standards specify quasi-peak and average values at given frequency levels. Varying the frequency of operation of the pulse width modulated switch by varying the oscillation frequency of the oscillator is referred to as frequency jitter.

A problem associated with the EMI reduction scheme described with respect to Fig. 1 is that the ripple component will have variances due to variations in the line voltage and output load. Additionally, since the ripple may vary, design and the component value of EMI resistor.

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140 is difficult to determine and correspondingly design of the power supply becomes problematic.

SUMMARY OF THE INVENTION

In one embodiment the present invention comprises a pulse width modulated switch comprising a switch that allows a signal to be transmitted between a first terminal and a second terminal according to a drive signal. The pulse width modulated switch also comprises a frequency variation circuit that provides a frequency variation signal and an oscillator that provides an oscillation signal having a frequency that varies within a frequency range according to the frequency variation signal. The oscillator further provides a maximum duty cycle signal comprising a first state and a second state. The pulse width modulated circuit further comprises a drive circuit that provides the drive signal when the maximum duty cycle signal is in the first state and a magnitude of the oscillation signal is below a variable threshold level.

Another embodiment of the present invention comprises a pulse width modulated switch comprising a switch comprising a control input, the switch allowing a signal to be transmitted between a first terminal and a second terminal according to a drive signal. The pulse width modulated switch also comprises an oscillator that provides a maximum duty cycle signal comprising an on-state and an off-state, a drive circuit that provides the drive signal, and a soft start circuit that provides a signal instructing said drive circuit to disable the drive signal during at least a portion of said on-state of the maximum duty cycle.

In an alternate embodiment the present invention comprises a regulation circuit comprising a switch that allows a signal to be transmitted between a first terminal and a second

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terminal according to a drive signal, a drive circuit that provides the drive signal and a soft start circuit that provides a signal instructing the drive circuit to disable the drive signal.

In yet another embodiment the present invention comprises a regulation circuit comprising a switch that allows a signal to be transmitted between a first terminal and a second terminal according to a drive signal, a frequency variation circuit that provides a frequency variation signal, and a drive circuit that provides a drive signal for a maximum time period of a time duration cycle. The time duration of the cycle varies according to the frequency variation signal.

In the above referenced embodiments the pulse width modulated switch or regulation circuit may comprise a monolithic device.

An object of an aspect of the present invention is directed to a pulse width modulated switch that has integrated soft start capabilities.

Another object of an aspect of the present invention is directed toward a pulse width modulated switch that has integrated frequency variation capabilities.

Yet another object of an aspect of the present invention is directed toward a pulse width modulated switch that has integrated frequency variation capabilities and integrated soft start capabilities.

A further object of an aspect of the present invention is directed toward a low cost regulated power supply that has both soft start and frequency variation capabilities.

This and other objects and aspects of the present inventions are taught, depicted and described in the drawings and the description of the invention contained herein.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a known power supply utilizing a pulse width modulated switch, and external soft start, and frequency jitter functionality.

Fig. 2 is a presently preferred power supply utilizing an pulse width modulated switch according to the present invention.

Fig. 3 is a presently preferred pulse width modulated switch according to the present invention.

Fig. 4 is a timing diagram of the soft start operation of the presently preferred pulse width modulated switch according to the present invention.

Fig. 5 is a timing diagram of the frequency jitter operation of the presently preferred pulse width modulated switch according to the present invention.

Fig. 6 is an alternate presently preferred pulse width modulated switch according to the present invention.

Fig. 7 is a timing diagram of the operation of the alternate presently preferred pulse width modulated switch of Fig. 6 according to the present invention.

Fig. 8 is a presently preferred power supply utilizing a regulation circuit according to the present invention.

Fig. 9 is a presently preferred regulation circuit according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Fig. 2, EMI filter 200 is coupled to an AC mains voltage 205. The AC mains voltage 205 is rectified by rectifier 210. The rectified voltage 215 is provided to power supply capacitor 220 which provides a substantially DC voltage 225. The substantially DC

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voltage 225 is provided to the primary winding 230 of transformer 235 which stores the energy provided to the primary winding 230. When the primary winding 230 is no longer receiving energy, energy is delivered by the transformer 235 to the secondary winding 240. The voltage induced across the secondary winding 240 is rectified by rectifier 245 and then transformed into secondary substantially DC voltage 265 by secondary capacitor 260 and provided to the power supply output 267.

Energy is no longer provided to the primary winding 230 when the pulse width modulated switch 262, which is coupled to the primary winding 230, ceases conduction. Pulse width modulated switch 262 is a switch that is controlled by a pulse width modulated signal. Pulse width modulated switch 262 conducts and ceases conduction according to a duty cycle, that is in part determined by feedback from the power supply output 267. Pulse width modulated switch 262 is a switch that operates according to pulse width modulated control. Feedback to the pulse width modulated switch 262 is accomplished by utilization of feedback circuit 270, which is presently preferred to comprise a zener diode 275 in series with a resistor 280 and optocoupler 285. Optocoupler 285 provides a feedback current 290 to feedback terminal 295 of pulse width modulated switch 262. The feedback current is utilized to vary the duty cycle of a switch coupled between the first terminal 300 and second terminal 305 and thus regulate the output voltage, current or power of the power supply.

Although, it is presently preferred that the output voltage is utilized for feedback, the present invention is also capable of utilizing either the current or power at the power supply output 267 without departing from the spirit and scope of the present invention.

A portion of the current supplied at the feedback terminal 295 is utilized to supply bias power for operation of the pulse width modulated switch 262. The remainder of the current

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input at the feedback terminal 295 is utilized to control the duty cycle of the pulse width modulated switch 262, with the duty cycle being inversely proportional to the feedback current.

A bias winding 310 is utilized to bias optocoupler 285 so that a feedback current can flow when light emitting diode 315 of optocoupler 285 conducts. The power supplied by the bias winding 310 is also used to charge pulse width modulation capacitor 330, the energy from which is utilized to power the pulse width modulated switch 262.

Overvoltage protection circuit 335 is utilized to prevent overvoltages from propagating through to the transformer 235.

Pulse width modulated switch 262 is supplied power during start up of the power supply by current flowing into the first terminal 300. An embodiment of one type of apparatus and method for designing a configuration for providing power to pulse width modulated switch through first terminal 300 is disclosed in commonly owned U.S. Patent No. 5,014,178 which is incorporated herein by reference in its entirety.

The drain terminal 300, source terminal 305 and feedback terminal 295 are the electrical input and/or output points of the pulse width modulated switch 262. They need not be part of a monolithic device or integrated circuit, unless the pulse width modulated switch 262 is implemented utilizing a monolithic device or integrated circuit.

Pulse width modulated switch 262 also may have soft start capabilities. When the device to which the power supply is coupled is switched on, a power up signal is generated within the internal circuitry of pulse width modulated switch 262. The power up signal is used to trigger soft start circuitry that reduces the duty cycle of the switch that operates within the pulse width modulated switch 262 for a predetermined period of time, which is presently preferred to be ten

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(10) milliseconds. Once soft start operation is completed, pulse width modulated switch 262 operates according to its regular duty cycle.

Alternatively, or in addition to soft start functionality, pulse width modulated switch 262 may also have frequency jitter functionality. That is, the switching frequency of the pulse width modulated switch 262 varies according to an internal frequency variation signal. This has an advantage over the frequency jitter operation of Fig. 1 in that the frequency range of the presently preferred pulse width modulated switch 262 is known and fixed, and is not subject to the line voltage or load magnitude variations. At low powers, those less than approximately ten (10) watts, the common mode choke which is often utilized as part of the EMI filter 120 can be replaced with inductors or resistors.

As can be seen when comparing the power supply of Fig. 1 to that of Fig. 2 the number of components utilized is reduced. This reduces the overall cost of the power supply as well as reducing its size.

Referring to Fig. 3, frequency variation signal 400 is utilized by the pulse width modulated switch 262 to vary its switching frequency within a frequency range. The frequency variation signal 400 is provided by frequency variation circuit 405, which preferably comprises an oscillator that operates at a lower frequency than main oscillator 465. The frequency variation signal 400, is presently preferred to be a triangular waveform that preferrably oscillates between four point five (4.5) volts and one point five (1.5) volts. Although the presently preferred frequency variation signal 400 is a triangular waveform, alternate frequency variation signals such as ramp signals, counter output signals or other signals that vary in magnitude during a fixed period of time may be utilized as the frequency variation signal.

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The frequency variation signal 400 is provided to soft start circuit 410. During operation soft start circuit 410 is also provided with pulse width modulation frequency signal 415 and power up signal 420. Soft start enable signal 421 goes high at power up and remains high until oscillator signal 400 reaches its peak value for the first time. Soft start circuit 410 will provide a signal to or-gate 425 to reset latch 430 thereby deactivating conduction by the switch 435, which is presently preferred to be a MOSFET. Soft start circuit 410 will instruct switch 435 to cease conduction when the soft start enable signal 421 is provided and the magnitude of the frequency variation signal 400 is less than the magnitude of pulse width modulation signal 415. In other words, start up circuit 410 will allow the switch 435 to conduct as long as soft start enable signal is high and the magnitude of the pulse width modulation signal 415 is below the magnitude of frequency variation signal 400 as depicted in Fig. 4. In this way, the inrush current at startup will be limited for all cycles of operation, including the first cycle. By limiting the inrush current during all cycles of startup operation, the maximum current through each of the components of the power supply is reduced and the maximum current rating of each component can be decreased. The reduction in the ratings of the components reduces the cost of the power supply. Soft start signal 440 will no longer be provided by the frequency variation circuit 405 when the frequency variation signal 400 reaches its peak magnitude.

Operation of soft start circuit 410 will now be explained. Soft start circuit 410 comprises a soft start latch 450 that at its set input receives the power up signal 420 and its reset input receives the soft start signal 440. Soft start enable signal 421 is provided to one input of soft start and-gate 455 while the other input of soft start and-gate 455 is provided with an output from soft start comparator 460. The output of soft start comparator 460 will be high when the

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magnitude of frequency variation signal 400 is less than the magnitude of pulse width modulation oscillation signal 415.

The pulse width modulated switch 262 depicted in Fig. 3 also has frequency jitter functionality to help reduce the EMI generated by the power supply and pulse width modulated switch 262. Operation of the frequency jitter functionality will now be explained. Main oscillator 465 has a current source 470 that is mirrored by mirror current source 475. Main oscillator drive current 615 is provided to the current source input 485 of PWM oscillator 480. The magnitude of the current input into current source input 485 of PWM oscillator 480 determines the frequency of the pulse width modulation oscillation signal 415 which is provided by PWM oscillator 480. In order to vary the frequency of pulse width modulation oscillation signal 415, an additional current source 495 is provided within main oscillator 465. The additional current source 495 is mirrored by additional current source mirror 500. The current provided by additional current source 495 is varied as follows. Frequency variation signal 400 is provided to the gate of main oscillator transistor 505. As the magnitude of frequency variation signal 400 increases so does the voltage at the source of main oscillator transistor 505, due to the increasing voltage at the gate of main oscillation transistor and the relatively constant voltage drop between the gate and source of the main oscillation transistor 505. As the voltage at the source of main oscillation transistor 505 increases so does the current flowing through the main oscillation resistor 510. The current flowing through main oscillation resistor 510 is the same as the current flowing through additional current source 495 which is mirrored by additional current source mirror 500. Since, the presently preferred frequency variation signal 400 is a triangular waveform having a fixed period, the magnitude of the current input by additional current source mirror 500 will vary linearly with the magnitude of the rising and falling edges of the frequency

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variation signal 400. If the frequency variation signal 400 is a ramp signal, the frequency would linearly rise to a peak and then immediately fall to is lowest value. In this way, the current provided to current source input 485 of PWM oscillator 480 is varied in a known fixed range that allows for easy and accurate frequency spread of the high frequency current generated by the pulse width modulated switch. Further, the variance of the frequency is determined by the magnitude of the current provided by additional current source mirror 500, which is in turn a function of the resistance of main oscillation resistor 510.

Frequency variation circuit 405 includes a current source 525 that produces a fixed magnitude current 530 that determines the magnitude of the frequency of the frequency variation signal 400. Although, the presently preferred current 530 has a fixed magnitude, the frequency variation signal can be generated utilizing a variable magnitude current, if a variable current is generated the frequency spread would not be fixed in time but would vary with the magnitude of current 530. The fixed magnitude current 530 is fed into first transistor 535, mirrored by second transistor 540 and fed into third transistor 545. The frequency variation signal 400 is generated by the charging and discharging of frequency variation circuit capacitor 550. Frequency variation circuit capacitor 550 is presently preferred to have a relatively low capacitance, which allows for integration into a monolithic chip in one embodiment of the pulse width modulated switch 262. The frequency variation signal 400 is provided to upper limit comparator 555 and lower limit comparator 560. The output of upper limit comparator 555 will be high when the magnitude of the frequency variation signal 400 exceeds the upper threshold voltage 552 which is presently preferred to be four point five (4.5) volts. The output of lower limit comparator 560 will be high when the magnitude of frequency variation signal 400 exceeds lower threshold voltage 557 which is presently preferred to be one point five volts (1.5) volts. The output of

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upper limit comparator 555 is provided to the frequency variation circuit inverter 565 the output of which is provided to the reset input of frequency variation circuit latch 570. The set input of frequency variation circuit latch 570 receives the output of lower limit comparator 560. In operation, the output of lower limit comparator 560 will be maintained high for the majority of each cycle of frequency variation signal 400 because the magnitude of frequency variation signal will be maintained between upper threshold 552, 4.5 volts, and the lower threshold 557, 1.5 volts. The output of upper limit comparator 555 will be low until the magnitude of frequency variation signal 400 exceeds upper level threshold 552. This means that the reset input will receive a high signal until the magnitude of the frequency variation signal 400 rises above the upper threshold signal 552.

The charge signal 575 output by frequency variation circuit latch 570 will be high until the frequency variation signal 400 exceeds the upper threshold limit signal 552. When the charge signal 575 is high, transistors 585 and 595 are turned off. By turning off transistors 585 and 595 current can flow into frequency variation circuit capacitor 550, which steadily charges frequency variation circuit capacitor 550 and increases the magnitude of frequency variation signal 400. The current that flows into frequency variation circuit capacitor 550 is derived from current source 525 because the current through transistor 590 is mirrored from transistor 580, which is mirrored from transistor 535.

During power up, when power-up signal 420 is low, the output of inverter 605 is high which turns on transistor 600 causing frequency variation signal 400 to go low. The frequency variation signal 400 is presently preferred to start from its lowest level to perform the soft start function during its first cycle of operation.

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Steady-state operation of the pulse width modulated switch 262, i.e. non-start up operation, will now be described. PWM oscillator 480 provides pulse width modulation oscillation signal 415 to pulse width modulation comparator 609, the output of which will be high when the magnitude of pulse width modulation signal 415 is greater than the magnitude of a feedback signal 296 which is a function of the input provided at feedback terminal 295. When the output of pulse width modulation comparator 609 is high or-gate 425 is triggered to go high, which in turn resets pulse width modulation latch 430, removing the on signal from the control input switch 435, thereby turning off switch 435. Pulse width modulation latch 430 is set by clock signal 603, which is provided at the beginning of each cycle of pulse width modulation oscillator 480. Drive circuit 615, which is presently preferred to be an and-gate, receives the output of pulse width modulation latch 430, power up signal 420, and maximum duty cycle signal 607. As long as each one of the signals is high, drive signal 610 is provided to the gate of MOSFET 435, which is coupled between first terminal 300 and second terminal 305 of the pulse width modulated switch 262. When any of the output of pulse width modulation latch 430, power up signal 420, or maximum duty cycle signal 607 goes low drive signal 610 is no longer provided and switch 435 ceases conduction.

Referring to Fig. 4, frequency variation signal 400 preferably has a period, which is greater than that of pulse width modulated oscillation signal 415. The presently preferred period for frequency variation signal 400 is twenty (20) milliseconds, in order to allow for a smooth start up period which is sufficiently longer than the period of pulse width modulated signal 415 which is presently preferred to be ten (10) microseconds. Drive signal 610 will be provided only when the magnitude of pulse width modulated signal 415 is less than the magnitude of frequency

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variation signal 400. Further, frequency variation signal 400 will be preferably initiated starting from low voltage when power up signal 420 is provided.

Referring to Fig. 5, frequency variation signal 400 which is presently preferred to have a constant period is provided to the main oscillator 465. The magnitude of the pulse width modulator current 615 will approximately be the magnitude of frequency variation signal 400 divided by the resistance of resistor 510 plus the magnitude of the current produced by current source 470. In this way the pulse width modulator current 615 will vary with the magnitude of the frequency variation signal 400. The result is that the frequency of pulse width modulation signal is varied according to the magnitude of this current. It is presently preferred that the pulse width modulator current source produces a constant current having a magnitude of twelve point one (12.1) microamperes, and that frequency variation signal induced current 627 varies between zero (0) and eight hundred (800) nanoamperes. Thereby spreading the frequency of operation of the pulse width modulation oscillator 480 and reducing the average magnitude and the quasi-peak magnitude at all frequency levels of the EMI generated by the power supply.

Referring to Fig. 6, an alternate presently preferred pulse width modulated switch 262 includes all of the same components as described with respect to Fig. 3. In addition to these components, a second frequency variation circuit current source 660 and transistor 655 are added to the frequency variation circuit 405. Transistor 655 is activated only when the output of soft start latch 450 goes low. When transistor 655 is activated the current provided to the frequency variation circuit 405 increases as does the frequency of frequency variation signal 400. However, transistor 655 will only be turned on when the output of soft start latch 450 goes low, i.e. when the magnitude of frequency variation signal 400 first reaches the upper threshold after power up. The period of frequency variation signal 400 will then increase after its first half

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cycle. This will decreases the period of the cycle during which the frequency is spread, without decreasing the frequency range. The benefit of the decreased cycle period will further decrease the quasi-peak levels of the EMI due to spending less time at each frequency level.

Referring to Fig. 7, operation of the frequency variation circuit 405 of Fig. 6 is depicted. Frequency variation signal 405 will preferably have a period of ten (10) milliseconds for its first half cycle. After that, when the transistor 655 is turned on the period is preferably decreased to five (5) milliseconds. Pulse width modulated switch 262 is presently preferred to be a monolithic device.

Referring to Fig. 8, a power supply comprises a bridge rectifier 710 that rectifies an input AC mains voltage. Power supply capacitors 720 charge with the rectified AC mains voltage to maintain an input DC voltage 725. A presently preferred range for input DC voltage 725 is approximately one hundred (100) to four hundred (400) volts to allow for operation based upon worldwide AC mains voltages which range between eighty five (85) and two hundred sixty five (265) volts. The presently preferred power supply also includes harmonic filter components 910 which in combination with capacitors 720 reduce the harmonic current injected back into the power grid. Transformer 730 includes a primary winding 740 magnetically coupled to secondary winding 750. The secondary winding 750 is coupled to a diode 760 that is designed to prevent current flow in the secondary winding 750 when the regulation circuit 850 is conducting (on-state). A capacitor 770 is coupled to the diode 760 in order to maintain a continuous voltage on a load 780 which has a feedback circuit coupled to it. A presently preferred feedback circuit comprises an optocoupler 800 and zener diode 820. The output of optocoupler 800 is coupled to the feedback terminal 825 of regulation circuit 850. The presently preferred regulation circuit 850 switches on and off at a duty cycle that is constant at a given input DC voltage 740. A

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regulation circuit power supply bypass capacitor 860 is coupled to and supplies power to regulation circuit 850 when the regulation circuit 850 is in the on-state.

Operation of the power supply will now be described. An AC mains voltage is input through EMI filter 700 into bridge rectifier 710 which provides a rectified signal to power supply capacitors 720 that provide input DC voltage 725 to primary winding 740. Regulation circuit 850, which preferably operates at a constant frequency and about constant duty cycle at a given input DC voltage 725, allows current to flow through primary winding 740 during its on state of each switching cycle and acts as open circuit in its off state. When current flows through primary winding 740 transformer 730 is storing energy, when no current is flowing through primary winding 740 any energy stored in transformer 730 is delivered to secondary winding 750. Secondary winding 750 then provides the energy to capacitor 770. Capacitor 770 delivers power to the load 780. The voltage across the load 780 will vary depending on the amount of energy stored in the transformer 730 in each switching cycle which is in turn dependent on the length of time current is flowing through primary winding 740 in each switching cycle which is presently preferred to be constant at a given input DC voltage 725. The presently preferred regulation circuit 850 allows the voltage delivered to the load to be maintained at a constant level.

It is presently preferred that the sum of the voltage drop across optocoupler 800 and the reverse break down voltage of zener diode 820 is approximately equal to the desired threshold level. When the voltage across the load 780 reaches the threshold level, current begins to flow through the optocoupler 800 and zener diode 820 that in turn is used to disable the regulation circuit 850. Whenever regulation circuit 850 is in the off-state the regulation circuit power supply bypass capacitor 860 is charged to the operating supply voltage, which is presently

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preferred to be five point seven (5.7) volts by allowing a small current to flow from bypass terminal 865 to the regulation circuit power supply bypass capacitor 860. Regulation circuit power supply bypass capacitor 860 is used to supply power to operate regulation circuit 850 when it is in the on-state.

When the regulation circuit 850 is disabled, an open circuit condition is created in primary winding 740 and transformer 730 does not store energy. The energy stored in the transformer 730 from the last cycle of regulation circuit 850 is then delivered to secondary winding 750 which in turn supplies power to the load 780. Once the remaining energy in transformer 750 is delivered to the load 780 the voltage of the load 780 will decrease. When the voltage at the load 780 decreases below the threshold level, current ceases to flow through optocoupler 800 and regulation circuit 850 resumes operation either instantaneously or nearly instantaneously.

The presently preferred regulation circuit 850 has a current limit feature. The current limit turns off the regulation circuit 850, when the current flowing through the regulation circuit 850 rises above a current threshold level. In this way regulation circuit 850 can react quickly to changes such as AC ripple that occur in the rectified AC mains voltage, and prevents the propagation of the voltage changes to the load. The current limit increases the responsiveness of the regulation circuit to input voltage changes and delivers constant power output independent for the AC mains input voltage.

Although the presently preferred power supply of Fig. 8 utilizes current mode regulation and a feedback circuit that includes an optocoupler and zener diode, the present invention is not to be construed as to be limited to such a feedback method or circuit. Either current or voltage mode regulation may be utilized by the present invention without departing from the spirit and

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scope of the present invention so long as a signal indicative of the power supplied to the load is supplied to the feedback terminal 825 of the regulation circuit 850. Additionally, although the presently preferred power supplies both utilize an optocoupler and zener diode as part of feedback circuits other feedback circuits may be utilized by the present invention without departing from the spirit and scope of the present invention.

Regulation circuit 850 also may have integrated soft start capabilities. When the device to which the power supply is coupled is switched on, a power up signal is generated within the internal circuitry of regulation circuit 850. A power up signal is used to trigger soft start circuitry that reduces the duty cycle of the switch that operates within the pulse width modulated switch 262 for a predetermined period of time, which is presently preferred to be ten (10) milliseconds. Once soft start operation is completed, regulation circuit 850 operates according to its regular duty cycle.

Alternatively, or in addition to soft start functionality, regulation circuit 850 may also have frequency jitter functionality. That is, the switching frequency of the regulation circuit 850 varies according to an internal frequency variation signal. This has an advantage over the frequency jitter operation of Fig. 1 in that the frequency range of the presently regulation circuit 850 is known and fixed, and is not subject to the line voltage or load magnitude variations.

Referring to Fig. 9, frequency variation circuit 405 and main oscillator 465 function as described with respect to Fig. 3. In operation it is the variance of the high and low states of maximum duty cycle signal 687 that generates the frequency jitter functionality of the regulation circuit 850. A presently preferred regulation circuit 850 and its steady-state operation is depicted and described in copending patent application serial No. 09/032,520 which is hereby incorporated by reference in its entirety.

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The regulation circuit of Fig. 9 can be modified to include a second current source to further increase the period of main oscillation signal 415 which achieves the same result and function as described with respect of Figs. 6 and 7.

The soft start functionality of the presently preferred regulation circuit 850 of Fig. 9, will shorten the on-time of switch 435 to less than the time of the maximum duty cycle signal 607 as long as the soft start enable signal 421 is provided and the magnitude of frequency variation signal 400 is less than the magnitude of main oscillation signal 415.

The presently preferred regulation circuit 850 preferably comprises a monolithic device.

While the embodiments, applications and advantages of the present invention have been depicted and described, there are many more embodiments, applications and advantages possible without deviating from the spirit of the inventive concepts described herein. Thus, the inventions are not to be restricted to the preferred embodiments, specification or drawings. The protection to be afforded this patent should therefore only be restricted in accordance with the spirit and intended scope of the following claims.

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CLAIMS

What Is Claimed Is:

1. A pulse width modulated switch comprising:

a first terminal;

a second terminal;

a switch comprising a control input, said switch allowing a signal to be transmitted between said first terminal and said second terminal according to a drive signal provided at said control input;

a frequency variation circuit that provides a frequency variation signal;

an oscillator that provides an oscillation signal having a frequency range, said frequency of said oscillation signal varying within said frequency range according to said frequency variation signal, said oscillator further providing a maximum duty cycle signal comprising a first state and a second state; and

a drive circuit that provides said drive signal when said maximum duty cycle signal is in said first state and a magnitude of said oscillation signal is below a variable threshold level.

2. The pulse width modulated switch of claim 1 wherein said first terminal, said second terminal, said switch, said oscillator, said frequency variation circuit and said drive circuit comprise a monolithic device.

3. The pulse width modulated switch of claim 1 wherein said frequency variation circuit comprises an additional oscillator that provides said frequency variation signal to said

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oscillator, said frequency of said oscillation signal varying within said frequency range according to said frequency variation signal.

4. The pulse width modulated switch of claim 1 further comprising a soft start circuit that provides a signal instructing said drive circuit to discontinue said drive signal when a magnitude of said oscillation signal is greater than a magnitude of said frequency variation signal.

5. The pulse width modulated switch of claim 4 wherein said additional oscillator provides a soft start signal, and wherein said soft start circuit ceases operation when said soft start signal is removed.

6. The pulse width modulated circuit of claim 5 wherein said additional oscillator further comprises

a comparator that provides a comparator signal when a magnitude of a reference signal is greater than or equal to a magnitude of said frequency variation signal; and

an inverter that receives said comparator signal and provides said soft start signal.

7. The pulse width modulated switch of claim 1 wherein said frequency of said oscillation signal varies within said frequency range with a magnitude of said frequency variation signal.

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8. The pulse width modulated switch of claim 1 wherein said oscillator comprises a an input that receives said frequency variation signal and a current source, wherein said frequency of said oscillation signal is a function of a sum of a magnitude of a current provided by said current source and a magnitude of said frequency variation signal.

9. The pulse width modulated switch of claim 1 further comprising

a rectifier comprising a rectifier input and a rectifier output, said rectifier input receiving an AC mains signal and said rectifier output providing a rectified signal;

a power supply capacitor that receives said rectified signal and provides a substantially DC signal;

a first winding comprising a first terminal and a second terminal, said first winding receiving said substantially DC signal, said second terminal of said first winding coupled to said first terminal of said pulse width modulated switch; and

a second winding magnetically coupled to said first winding, said first winding capable of being coupled to a load.

10. The pulse width modulated switch of claim 1 wherein said variable threshold level is a function of a feedback signal received at a feedback terminal of said pulse width modulated switch.

11. A pulse width modulated switch comprising

a first terminal;

a second terminal;

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a switch comprising a control input, the switch allowing a signal to be transmitted between said first terminal and said second terminal according to a drive signal provided at said control input;

an oscillator that provides a maximum duty cycle signal comprising an on-state and an off-state;

a drive circuit that provides said drive signal according to said maximum duty cycle signal; and

a soft start circuit that provides a signal instructing said drive circuit to disable said drive signal during at least a portion of said on-state of said maximum duty cycle.

2. The pulse width modulated switch of claim 1 wherein said a first terminal, said second terminal, said switch, said oscillator, said drive circuit and said soft start circuit comprise a monolithic device.

3. The pulse width modulated switch of claim 1 further comprising an additional oscillator that provides a soft start signal to said soft start circuit, and wherein when said soft start signal is removed said soft start circuit ceasing operation.

4. The pulse width modulated circuit of claim 3 wherein said additional oscillator further comprises

a comparator that provides a comparator signal when a magnitude of a reference signal is greater than or equal to a magnitude of said frequency variation oscillation signal, and

an inverter that receives said comparator signal and provides said soft start signal.

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15. The pulse width modulated switch of claim 14 further comprising a frequency variation circuit that provides a frequency variation signal, wherein said oscillator provides an oscillation signal and wherein said soft start circuit provides said signal instructing said drive circuit to disable said drive signal when a magnitude of said oscillation signal is greater than a magnitude of said frequency variation signal.

16. The pulse width modulated switch of claim 15 wherein said oscillator comprises an input that receives said frequency signal and said oscillation signal comprises a frequency range, and wherein said frequency of said oscillation signal varies within said frequency range according to a magnitude of said frequency variation signal.

17. The pulse width modulated switch of claim 16 wherein said oscillator further comprises a current source, wherein said frequency of said oscillation signal is a function of a sum of a magnitude of a current provided by said current source and said magnitude of said frequency variation signal.

18. The pulse width modulated switch of claim 14 further comprising

a rectifier comprising a rectifier input and a rectifier output, said rectifier input receiving an AC mains signal and said rectifier output providing a rectifier signal;

a power supply capacitor that receives said rectified signal;

a first winding comprising a first terminal and a second terminal, said first winding receiving a substantially DC signal from said power supply capacitor, said second terminal of said first winding coupled to said first terminal of said pulse width modulated switch; and

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a second winding magnetically coupled to said first winding, said first winding capable of being coupled to a load.

9 19. A regulation circuit comprising

a first terminal;

a second terminal;

a switch comprising a control input, said switch allowing a signal to be transmitted between said first terminal and said second terminal according to a drive signal provided at said control input;

a drive circuit that provides said drive signal for a maximum time period of a cycle; and

a soft start circuit that provides a signal instructing said drive circuit to disable said drive signal during at least a portion of said maximum time period.

10 20. The regulation circuit of claim 9 further comprising an oscillator that provides a maximum duty cycle signal to said drive circuit, said maximum duty cycle signal comprising an on-state for said maximum time period.

11 21. The regulation circuit of claim 10 further comprising a frequency variation circuit that provides a frequency variation signal, wherein said oscillator provides an oscillation signal and wherein said soft start circuit provides said signal instructing said drive circuit to disable said drive signal when a magnitude of said oscillation signal is greater than a magnitude of said frequency variation signal.

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12 22. The regulation circuit of claim 9 further comprising an additional oscillator that provides a soft start signal to said soft start circuit, and wherein when said soft start signal is removed said soft start circuit ceasing operation.

13 25. The regulation circuit of claim 12 wherein said additional oscillator further comprises

a comparator that provides a comparator signal when a magnitude of a reference signal is greater than or equal to a magnitude of said additional oscillation signal, and

an inverter that receives said comparator signal and provides said soft start signal.

14 26. The regulation circuit of claim 9 further comprising a frequency variation circuit that provides a frequency variation signal and wherein said maximum time period varies according to a magnitude of said frequency variation signal.

15 26. The regulation circuit of claim 9 further comprising a feedback terminal and wherein when a signal is received at said feedback terminal said drive signal is discontinued for at least one cycle.

16 26. The regulation circuit of claim 9 wherein said first terminal, said second terminal, said oscillator and said soft start circuit comprise a monolithic device.

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17. The regulation circuit of claim 16 further comprising a current limit circuit that provides a signal instructing said drive circuit to discontinue said drive signal when a current received at said first terminal of said regulation circuit is above a threshold level.

18. The regulation circuit of claim 9 further comprising

a rectifier comprising a rectifier input and a rectifier output, said rectifier input receiving an AC mains signal and said rectifier output providing a rectifier signal;

a power supply capacitor that receives said rectified signal;

a first winding comprising a first terminal and a second terminal, said first winding receiving a substantially DC signal from said power supply capacitor, said second terminal of said first winding coupled to said first terminal of said regulation circuit; and,

a second winding magnetically coupled to said first winding, said first winding capable of being coupled to a load.

20. A regulation circuit comprising:

a first terminal;

a second terminal;

a switch comprising a control input, said switch allowing a signal to be transmitted between said first terminal and said second terminal according to a drive signal provided at said control input; and

a frequency variation circuit that provides a frequency variation signal;

a drive circuit that provides said drive signal for a maximum time period of a time duration cycle;

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wherein said time duration of said cycle varies according to said frequency variation signal.

30. The regulation circuit of claim 29 wherein said frequency variation circuit comprises an oscillator that provides said frequency variation signal.

31. The regulation circuit of claim 29 further comprising a soft start circuit that provides a signal instructing said drive circuit to discontinue said drive according to a magnitude of said frequency variation signal.

32. The regulation circuit of claim 31 further wherein said frequency variation circuit provides a soft start signal, and wherein said soft start circuit ceases operation when said soft start signal is removed.

33. The regulation circuit of claim 32 wherein said frequency variation circuit further comprises

a comparator that provides a comparator signal when a magnitude of a reference signal is greater than or equal to a magnitude of said frequency variation signal, and

an inverter that receives said comparator signal and provides said soft start signal.

34. The regulation circuit of claim 29 wherein said first terminal, said second terminal, said switch, said frequency variation circuit, and said drive circuit comprise a monolithic device.

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35. The regulation circuit of claim 29 further comprising

a rectifier comprising a rectifier input and a rectifier output, said rectifier input receiving an AC mains signal and said rectifier output providing a rectified signal;

a power supply capacitor that receives said rectified signal and provides a substantially DC signal;

a first winding comprising a first terminal and a second terminal, said first winding receiving said substantially DC signal, said second terminal of said first winding coupled to said first terminal of said regulation circuit; and

a second winding magnetically coupled to said first winding, said first winding capable of being coupled to a load.

36. The regulation circuit of claim 29 further comprising a current limit circuit that provides a signal instructing said drive circuit to discontinue said drive signal when a current received at said first terminal of said regulation circuit is above a threshold level.

37. The regulation circuit of claim 29 further comprising a feedback terminal and wherein when a signal is received at said feedback terminal said drive signal is discontinued for at least one cycle.

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ABSTRACT

A pulse width modulated switch comprises a first terminal, a second terminal, and a switch that allows a signal to be transmitted between the first terminal and the second terminal according to a drive signal provided at a control input. The pulse width modulated switch also comprises a frequency variation circuit that provides a frequency variation signal and an oscillator that provides an oscillation signal having a frequency of that varies within a frequency range according to the frequency variation signal. The oscillator further provides a maximum duty cycle signal comprising a first state and a second state. The pulse width modulated switch further comprises a drive circuit that provides the drive signal when the maximum duty cycle signal is in the first state and a magnitude of the oscillation signal is below a variable threshold level.

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Docket No: 233/248
May 18, 1998

DECLARATION
AND POWER OF ATTORNEY
Utility Application

LYON & LYON LLP

233/248

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled "OFF-LINE CONVERTER WITH INTEGRATED SOFTSTART AND FREQUENCY JITTER", the specification of which

Check One

☒ is attached hereto.

☐ was filed on _____ as Application Serial No. _____ and was amended on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above. I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Application Number	Country	Date of Filing	Priority Claimed Yes%	Priority Claimed No%

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

Application Number	Date of Filing	Status--Patented, Pending or Abandoned

POWER OF ATTORNEY: As a named inventor, I hereby appoint as my attorneys, with full power of substitution and revocation, to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Roland N. Smoot, Reg. No. 18,718; Conrad R. Solum, Jr. Reg. No. 20,467; James W. Geriak, Reg. No. 20,233; Robert M. Taylor, Jr., Reg. No. 19,848; Samuel B. Stone, Reg. No. 19,287; Douglas E. Olson, Reg. No. 22,798; Robert E. Lyon, Reg. No. 24,171; Robert C. Weiss, Reg. No. 24,939; Richard E. Lyon, Jr., Reg. No. 26,300; John D. McConaghy, Reg. No. 26,773; William C. Stallte, Reg. No. 26,811; Cos A. Bloomberg, Reg. No. 26,603; J. Donald McCarthy, Reg. No. 25,119; John M. Benassi, Reg. No. 27,483; James H. Shalek, Reg. No. 29,749; Allan W. Jansen, Reg. No. 29,395; Robert W. Dickerson, Reg. No. 29,914; Roy L. Anderson, Reg. No. 30,240; David B. Murphy, Reg. No. 31,125; James C. Brooks, Reg. No. 29,898; Jeffrey M. Olson, Reg. No. 30,790; Steven D. Hemminger, Reg. No. 30,755; Jerrold B. Kelly, Reg. No. 32,295; Paul H. Meier, Reg. No. 32,274; John A. Rafter, Jr., Reg. No. 31,613; Kenneth H. Ohriner, Reg. No. 31,646; Mary S. Consalvi, Reg. No. 32,212; Lois M. Kwasigroch, Reg. No. 35,579; Lawrence R. LaPorte, Reg. No. 38,948; Robert C. Laurenson, Reg. No. 34,206; Carol A. Schneider, Reg. No. 34,923; Hope E. Melville, Reg. No. 34,874; Michael J. Wise, Reg. No. 34,047; Richard J. Warburg, Reg. No. 33,327; David T. Buse, Reg. No. 37,104; Jeffrey A. Miller, Reg. No.35,287; Bernard F. Rose, Reg. No. P-42,112; Michael J. Bolan, Reg. No. P-42,339; Lynn Y. McKeman, Reg. No. P-41,986; and Dmitry R. Milikovsky, Reg. No. P-41,999.

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Update 4/97

Send Correspondence to: LYON & LYON LLP
47th Floor, 633 W. Fifth St.
Los Angeles, CA 90071

Direct Telephone
Calls to: Dmitry R. Milikovsky
(408) 993-1555

	FULL NAME OF INVENTOR	FIRST Name Balu	Middle Initial	LAST Name Balakrishnan	
201	RESIDENCE & CITIZENSHIP	City Saratoga	State or Foreign Country California	Country of Citizenship United States of America	
	POST OFFICE ADDRESS	Post Office Address 13917 Albar Court	City Saratoga	State or Country California	Zip Code 95070
	FULL NAME OF INVENTOR	FIRST Name Alex	Middle Initial	LAST Name Djenguerian	
202	RESIDENCE & CITIZENSHIP	City Saratoga	State or Foreign Country California	Country of Citizenship United States of America	
	POST OFFICE ADDRESS	Post Office Address 20602 Sevilla Lane	City Saratoga	State or Country California	Zip Code 95070
	FULL NAME OF INVENTOR	FIRST Name Leif	Middle Initial	LAST Name Lund	
203	RESIDENCE & CITIZENSHIP	City San Jose	State or Foreign Country California	Country of Citizenship Sweden	
	POST OFFICE ADDRESS	Post Office Address 1074 Queensbrook Drive	City San Jose	State or Country California	Zip Code 95129
	FULL NAME OF INVENTOR	FIRST Name	Middle Initial	LAST Name	
204	RESIDENCE & CITIZENSHIP	City	State or Foreign Country	Country of Citizenship	
	POST OFFICE ADDRESS	Post Office Address	City	State or Country	Zip Code

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I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signature of Inventor 201: Balu Balakrishnan	
Date: 5-14-98	
Signature of Inventor 202: Alex Djenguerian	
Date: 5/14/98	
Signature of Inventor 203: Leif Lund	
Date: 05-14-98	

(Signatures should conform to names as presented at 201 et seq. above.)

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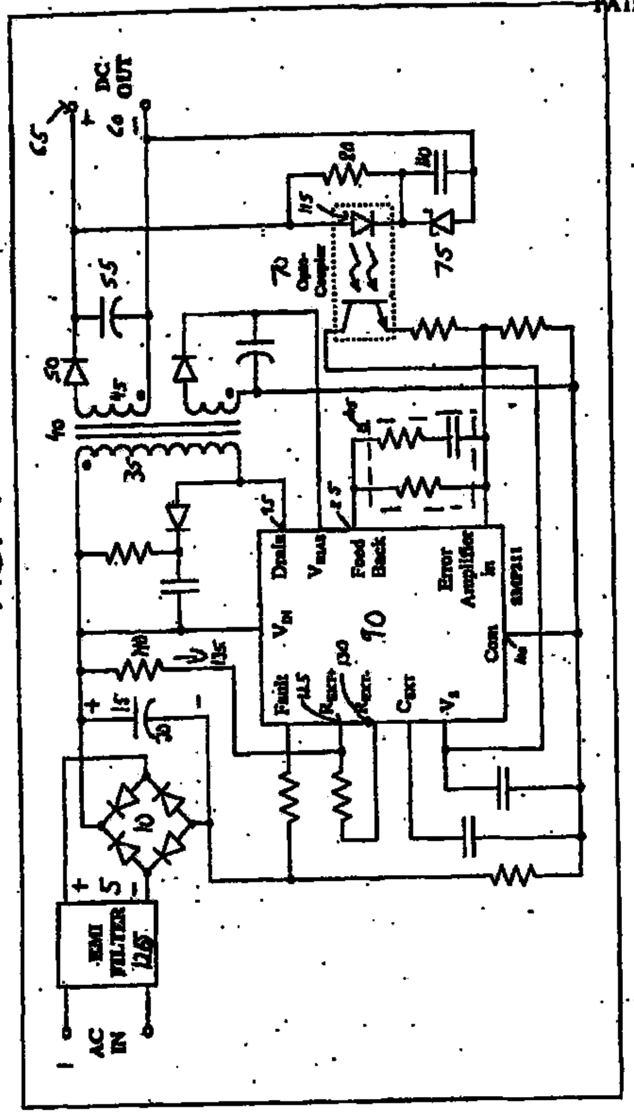

FIG. 1

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May 18, 1998

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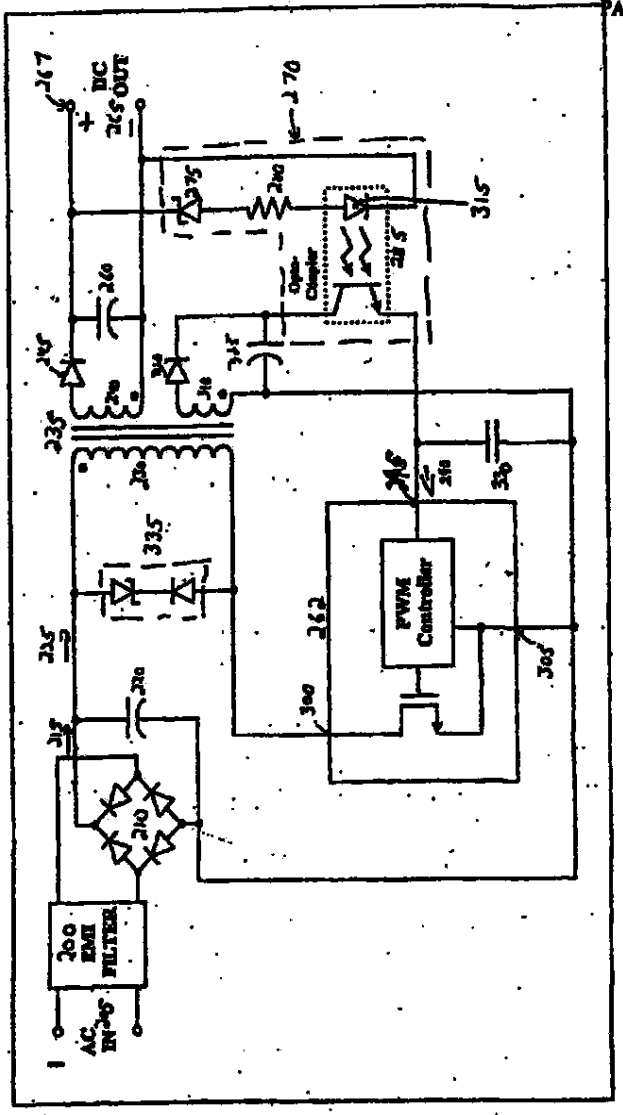

FIG. 2

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May 18, 1998

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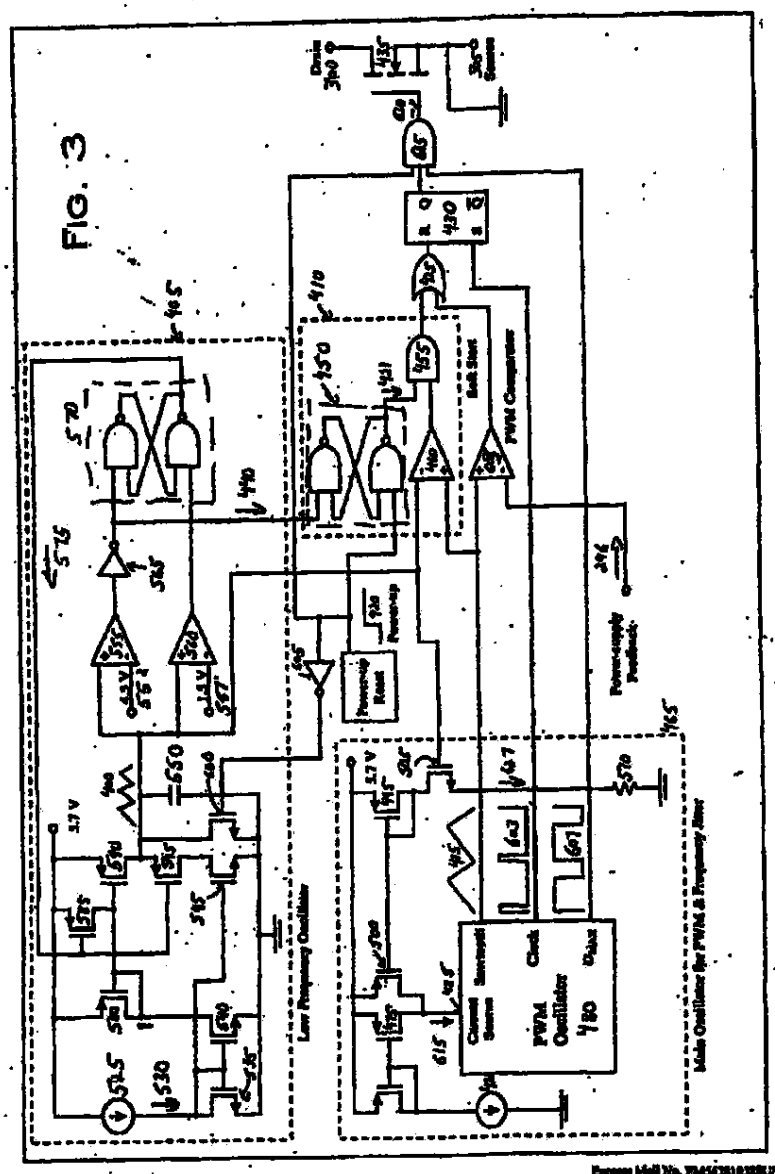
FIG. 3



35

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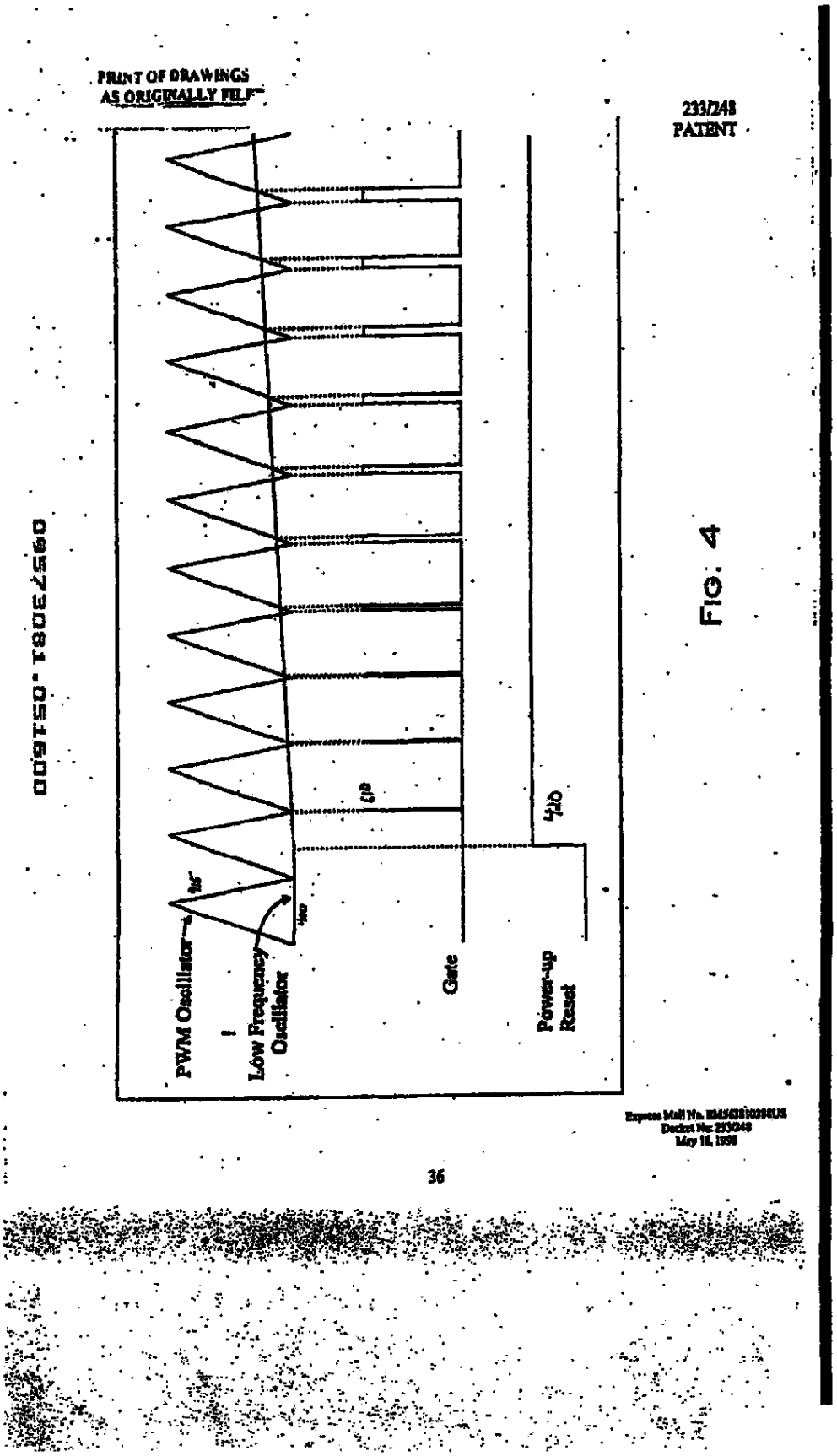
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PWM Oscillator
Low Frequency
Oscillator
Gate
Power-up
Reset
Fig. 4
36

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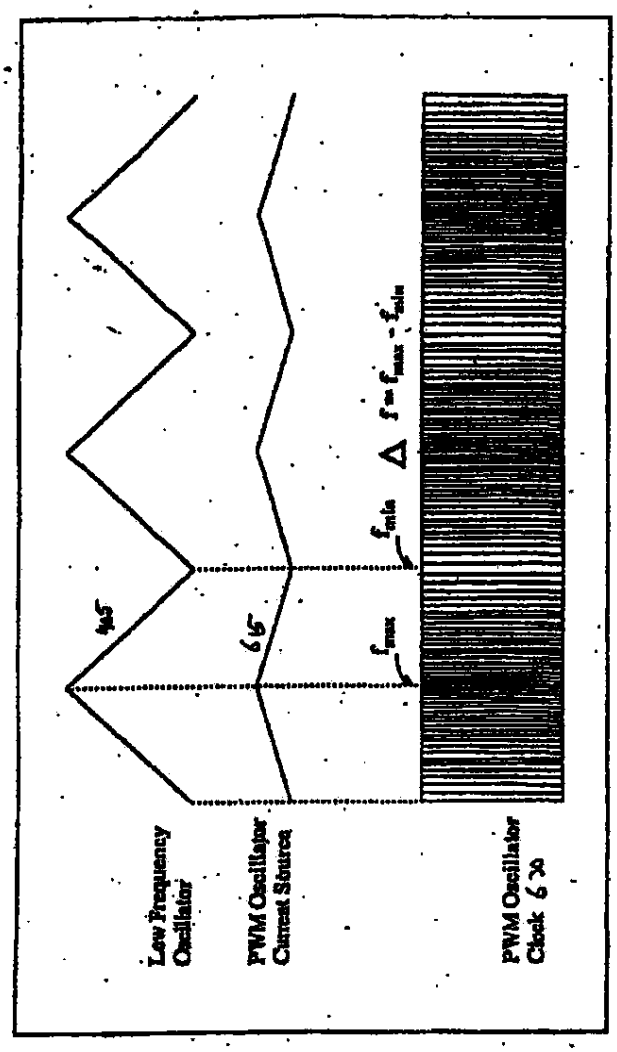

FIG. 5

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May 18, 1998

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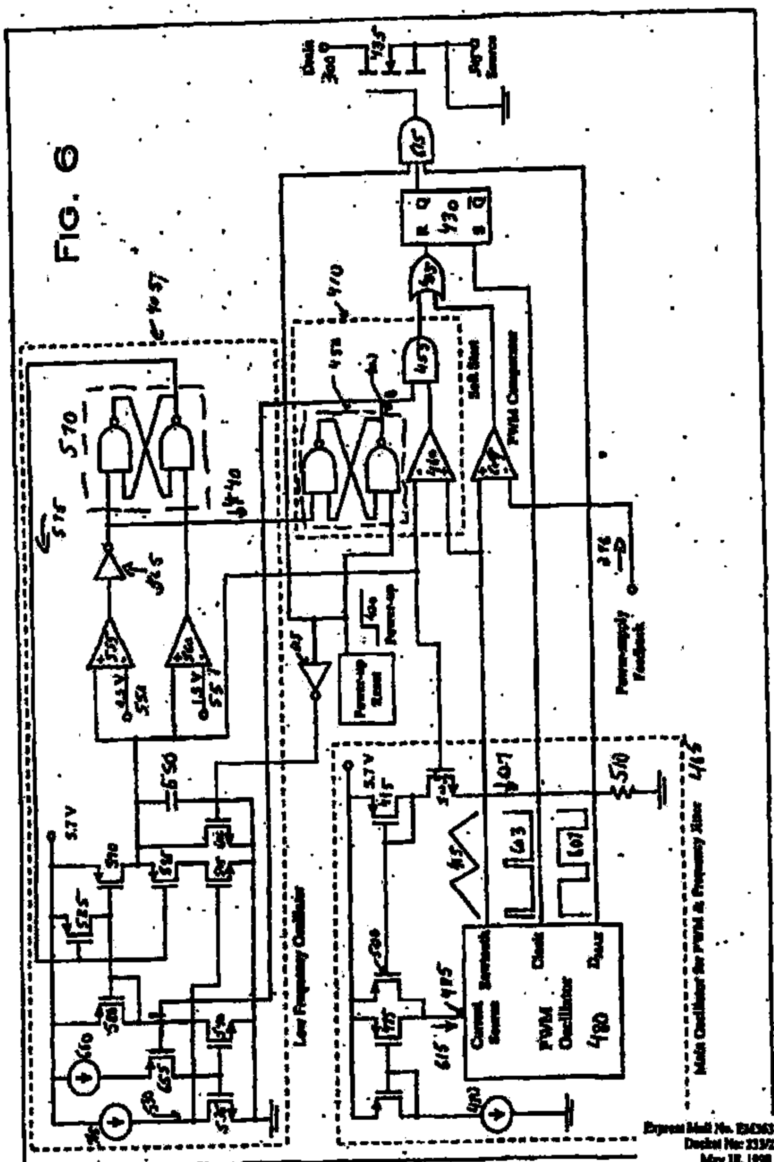

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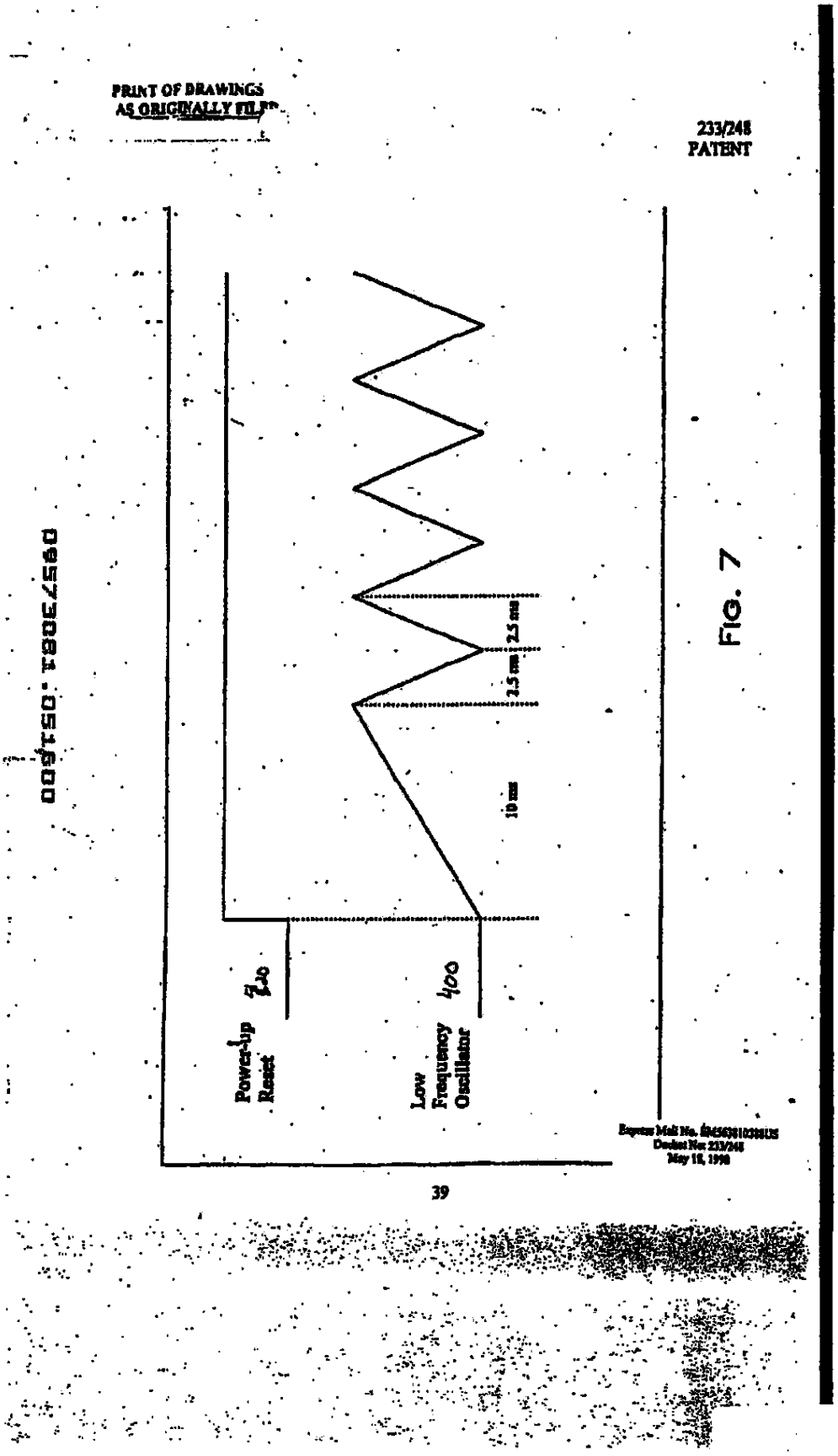
Docket No: 233/248
May 18, 1998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2.5 ms
2.5 ms
10 ms
Power-up
Reset
Low
Frequency
Oscillator
39
FIG. 7

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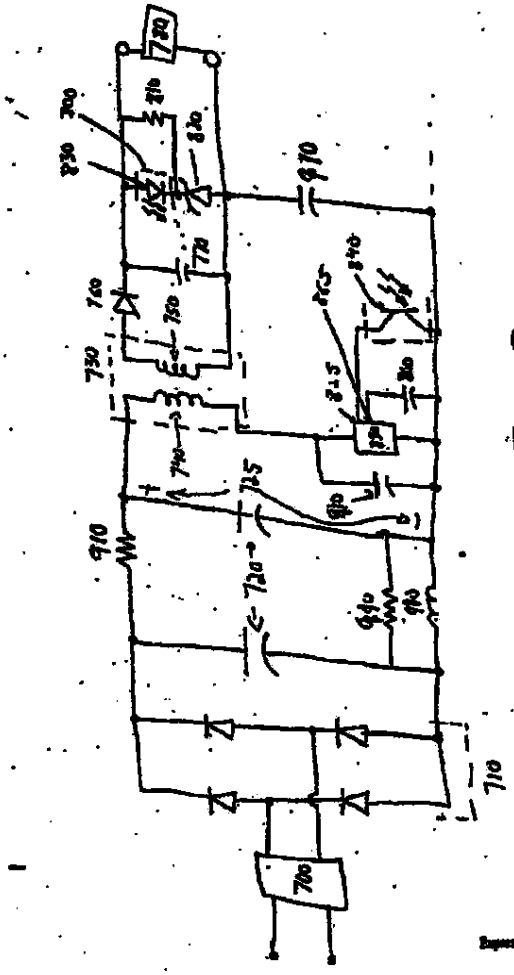

FIG. 8

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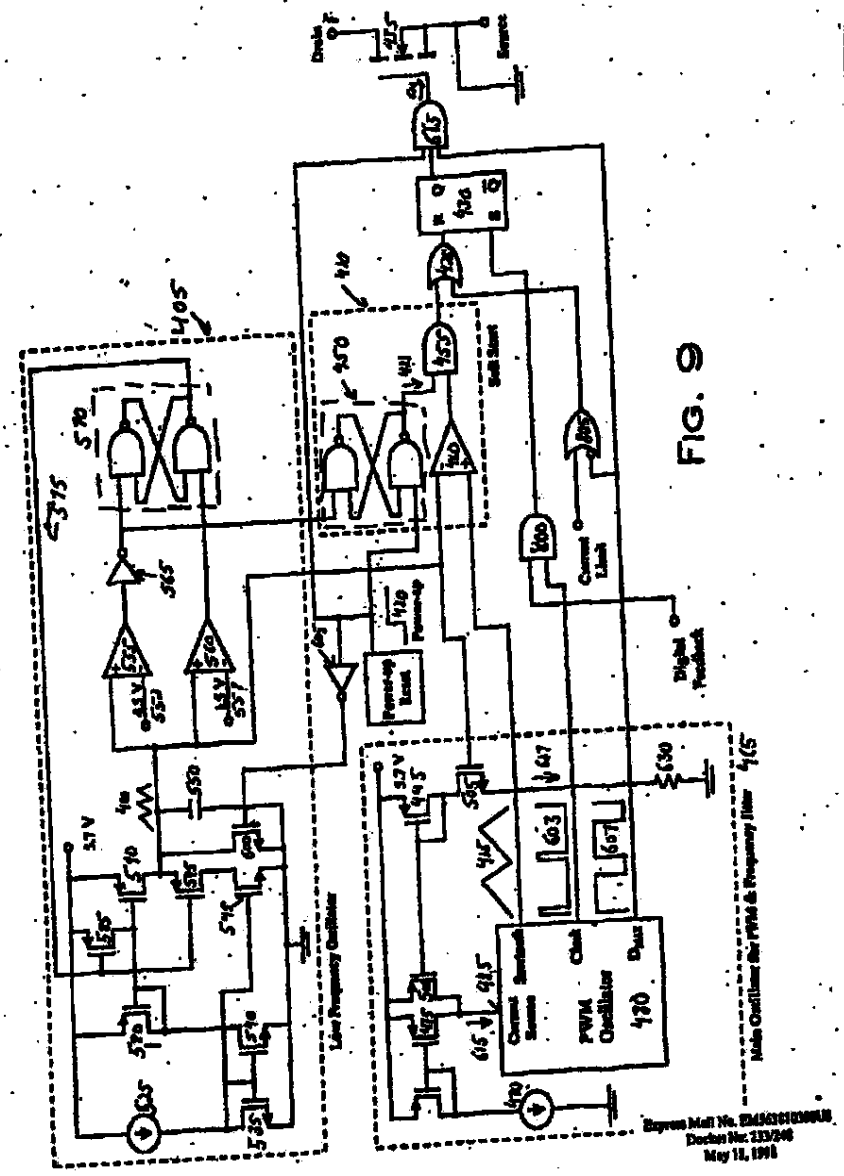

FIG. 9

41

3 / Prel. Amdt; A
11-15-00

003692.P036D

Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

BALAKRISHNAN ET AL.

Serial No. New Application

Filed: Herewith

For: OFF-LINE CONVERTER WITH INTEGRATED SOFTSTART AND FREQUENCY JITTER

Examiner: Unknown

Art Unit: Unknown

PRELIMINARY AMENDMENT

Box Patent Application
Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Prior to examination of the above referenced application, the Applicants respectfully request the Examiner to enter the following amendments and to consider the following remarks.

IN THE SPECIFICATION

On page 1, line 5, please insert the following:

A1

--Cross-Reference To Related Application

This is a Divisional of U.S. Application Serial No. 09/080,774, filed May 18, 1998, now USPN 6,107,851 ~~pending~~.--

IN THE CLAIMS

Please cancel claims 1-10 and 29-37 without prejudice:

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09572084 - 051600

REMARKS

The present application is a divisional of U.S. Application Serial No. 09/080,774. Claims 1-10 and 29-37 are canceled herein. Claims 11-28 are now pending for examination. An IDS and fees to cover the pending claims are being submitted with this preliminary amendment. Allowance of all pending claims is earnestly solicited.

Charge Deposit Account

Please charge our Deposit Account No. 02-2666 for any additional fee due in this matter.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR and ZAFMAN

Dated: 5-16-00

James Y. Go,
Reg. No. 40,621

"Express Mail" mailing label number: EL416992068US
Date of Deposit: May 16, 2000
I hereby certify that I am causing this paper or fee to be deposited with the United States Postal Service "Express Mail Post Office to Addressee" service on the date indicated above and that this paper or fee has been addressed to the Assistant Commissioner for Patents, Washington, D. C. 20231
Melanie Ramakay
(Typed or printed name of person mailing paper or fee)
Melanie Ramakay 5-16-00
(Signature of person mailing paper or fee) (Date signed)

3/IDS
E. Williams
11-15-00

Attorney's Docket No. 003692.P036D PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Patent Application of:

Balakrishnan et al.

Application No.: New Application

Filed: Herewith

For: OFF-LINE CONVERTER WITH INTEGRATED SOFTSTART AND FREQUENCY JITTER

Examiner: Not Yet Assigned

Art Unit: Not Yet Assigned

Assistant Commissioner for Patents
Washington, D.C. 20231

INFORMATION DISCLOSURE STATEMENT

Sir:

Enclosed is a copy of Information Disclosure Citation Form PTO-1449 together with copies of the documents cited on that form. It is respectfully requested that the cited documents be considered and that the enclosed copy of Information Disclosure Citation Form PTO-1449 be initialed by the Examiner to indicate such consideration and a copy thereof returned to applicant(s).

Pursuant to 37 C.F.R. § 1.97, the submission of this Information Disclosure Statement is not to be construed as a representation that a search has been made and is not to be construed as an admission that the information cited in this statement is material to patentability.

Pursuant to 37 C.F.R. § 1.97, this Information Disclosure Statement is being submitted under one of the following (as indicated by an "X" to the left of the appropriate paragraph):

XXX 37 C.F.R. §1.97(b).

___ 37 C.F.R. §1.97(c). If so, then enclosed with this Information Disclosure Statement is one of the following:

___ A statement pursuant to 37 C.F.R. §1.97(e) or

___ A check for $240.00 for the fee under 37 C.F.R. § 1.17(p).

___ 37 C.F.R. §1.97(d). If so, then enclosed with this Information Disclosure Statement are the following:

(1) A statement pursuant to 37 C.F.R. §1.97(e);

(2) A petition requesting consideration of the Information Disclosure Statement; and

(3) A check for $_____ for the fee under 37 C.F.R. §1.17(i) for submission of the Information Disclosure Statement.

If there are any additional charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: 5-16, 2000

James Y. Go
Reg. No. 40,621

12400 Wilshire Blvd.
Seventh Floor
Los Angeles, CA 90025-1026
(425) 827-8600

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to the Assistant Commissioner for Patents, Washington, D. C. 20231 on May 16, 2000
(Date of Deposit)

Melanie Beaucler
(Typed or printed name of person mailing correspondence)

Melanie Beaucler 5-16-00
(Signature of person mailing correspondence)

4

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/573,881	05/16/00	BALAKRISHNAN	H 003692.P0360

EXAMINER

MM92/1213

JAMES Y GO
BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP
12400 WILSHIRE BOULEVARD
SEVENTH FLOOR
LOS ANGELES CA 90025-1026

ZIMMERMAN, J	PAPER NUMBER

#4

ART UNIT

12/13/00

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

PTO-90C (Rev. 2/95)
*U.S. GPO: 2000-475-000/44402

3- File Copy

Notice of Allowability	Application No. 09/873,091	Applicant(s) BALAKRISHNAN ET AL.
	Examiner Jeffrey S. Zweizig	Art Unit 2816

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance and Issue Fee Due or other appropriate communication will be mailed in due course.

1. ☒ This communication is responsive to the application filed 5/18/01.
2. ☒ The allowed claim(s) is/are 11-28.
3. ☐ The drawings filed on ____ are acceptable.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).
   a) ☐ All b) ☐ Some* c) ☐ None of the CERTIFIED copies of the priority documents have been
      1. ☐ received.
      2. ☐ received in Application No. (Series Code / Serial Number). ____.
      3. ☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
   * Certified copies not received: ____.
5. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e).

A SHORTENED STATUTORY PERIOD FOR REPLY to comply with the requirements noted below is set to EXPIRE THREE MONTHS FROM THE "DATE MAILED" of this Office Action. Failure to timely comply will result in ABANDONMENT of this application. Extensions of time may be available under the provisions of 37 CFR 1.136(a).

6. ☐ Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient. A SUBSTITUTE OATH OR DECLARATION IS REQUIRED.

7. ☒ Applicant MUST submit NEW FORMAL DRAWINGS
   (a) ☐ because the originally filed drawings were declared by applicant to be informal.
   (b) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review(PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No. ____.
   (c) ☐ including changes required by the proposed drawing correction filed ____, which has been approved by the examiner.
   (d) ☒ including changes required by the attached Examiner's Amendment / Comment.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the reverse side of the drawings. The drawings should be filed as a separate paper with a transmittal letter addressed to the Official Draftsperson.

8. ☐ Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Any reply to this letter should include, in the upper right hand corner, the APPLICATION NUMBER (SERIES CODE / SERIAL NUMBER). If applicant has received a Notice of Allowance and Issue Fee Due, the ISSUE BATCH NUMBER and DATE of the NOTICE OF ALLOWANCE should also be included.

Attachment(s)

1 ☒ Notice of References Cited (PTO-892)
2 ☐ Notice of Informal Patent Application (PTO-152)
3 ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
4 ☐ Interview Summary (PTO-413), Paper No. ____.
5 ☒ Information Disclosure Statements (PTO-1449), Paper No. 3.
6 ☐ Examiner's Amendment/Comment
7 ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
8 ☒ Examiner's Statement of Reasons for Allowance
9 ☐ Other

JEFFREY ZWEIZIG
PRIMARY EXAMINER

U.S. Patent and Trademark Office
PTO-37 (Rev. 3-96) Notice of Allowability Part of Paper No. 4

Drawings

1. Fig. 1 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g).

Allowable Subject Matter

2. The present invention is directed toward a pulse width modulation circuit comprising a switching transistor wherein the switching transistor can be driven into a non-conducting state by a maximum duty cycle signal, a drive circuit, or a soft start circuit.

Conclusion

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jeffrey S. Zweizig whose telephone number is (703) 305-7243. The examiner can normally be reached on Monday - Friday, 5:30 am - 2:00 pm (eastern time).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy P. Callahan can be reached on (703) 308-4876. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

Jeffrey S. Zweizig
Primary Examiner
Art Unit 2816

JZ
December 13, 2000

Notice of References Cited	Application/Control No. 09/573,091	Applicant(s)/Patent Under Reexamination BALAKRISHNAN ET AL.
	Examiner Jeffrey B. Zweizig	Art Unit 2616 — Page 1 of 1

U.S. PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS	DOCUMENT SOURCE ** APS	OTHER
☒	A	5,245,628	Sep. 1993	Balakrishnan et al.	383	97	☐	☐
☒	B	5,021,937	Jun. 1991	Cohen	363	41	☐	☐
☐	C						☐	☐
☐	D						☐	☐
☐	E						☐	☐
☐	F						☐	☐
☐	G						☐	☐
☐	H						☐	☐
☐	I						☐	☐
☐	J						☐	☐
☐	K						☐	☐
☐	L						☐	☐
☐	M						☐	☐

FOREIGN PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUBCLASS	DOCUMENT SOURCE ** APS	OTHER
☐	N							☐	☐
☐	O							☐	☐
☐	P							☐	☐
☐	Q							☐	☐
☐	R							☐	☐
☐	S							☐	☐
☐	T							☐	☐

NON-PATENT DOCUMENTS

*		DOCUMENT (Including Author, Title Date, Source, and Pertinent Pages)	DOCUMENT SOURCE ** APS	OTHER
☐	U		☐	☐
☐	V		☐	☐
☐	W		☐	☐
☐	X		☐	☐

*A copy of this reference is not being furnished with this Office action. (See Manual of Patent Examining Procedure, Section 707.05(a).)
**APS encompasses any electronic search i.e. text, image, and Commercial Databases.
U.S. Patent and Trademark Office
PTO-892 (Rev. 03-99) Notice of References Cited Part of Paper No. 4

Please type a plus sign (+) inside this box ____

PTO/SB/08A (10-00)
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Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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Substitute for form 1449/PTO
(Modified by BSTZ 8/30/99)

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Complete if Known	
Application Number	New Application 09/573081
Filing Date	Herewith 5/16/00
First Named Inventor	Balu Balakrishnan
Group Art Unit	
Examiner Name	
Attorney Docket Number	003592.P036D

Sheet 1 of 6

U.S. PATENT DOCUMENTS

Examiner Initials*		U.S Patent Document Number	Name of Patentee or Applicant of Cited Document		Date of Publication of Cited Document MM-DD-YYYY	Filing Date if Appropriate
JZ		3,491,252	Petrohilos	307/229	1/20/1970	11/16/1964
JZ		3,555,398	Buchanan et al	321/43	1/21/1971	11/16/2067
JZ		3,840,797	Aggen et al	321/2	10/08/1974	12/28/1970
JZ		3,916,224	Daniels et al	307/264	10/28/1975	8/2/1973
JZ		4,072,985	Konda	354/51	2/7/1978	3/15/1976
JZ		4,119,282	Berard, Jr. et al	307/43	3/6/1979	12/3/1976
JZ		4,228,493	de Sarbo et al	363/56	10/14/1980	12/21/1978
JZ		4,236,198	Chesavs et al	363/49	11/25/1980	12/11/1978
JZ		4,495,554	Sinl et al	363/21	1/22/1985	3/28/1983
JZ		4,539,690	Davidson	363/21	12/17/1985	3/24/1983

FOREIGN PATENT DOCUMENTS

Examiner Initials*		Foreign Patent Document Office or Country	Number	Date	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation? Yes/No
JZ		EPO	WO 83/01167	3/31/1983			No
JZ		EPO	O 851 440 Al	5/3/1995			No
JZ		EPO	EP O 694 966 Al	1/3/1996			No
JZ		EPO	EP O 736 957 Al	10/9/1996			No
JZ		EPO	EP O 740 491 Al	10/30/1996			No

OTHER DOCUMENTS

Examiner Initials*		Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published (if known).	Translation? Yes/No
JZ		H.S. Hoffman, Jr., "Self-Generated Bias Supply", IBM Technical Disclosur Bulletin, Vol. 20, No. 5, October 1997, pp. 1814-4.	
JZ		H.S. Hoffman, Jr. et al, "Proportional Drive Supply with Division Control", IBM Technical Disclosure Bulletin, Vol. 21, No. 12, May 1979, pp. 4904-5	
JZ		A. Halpain, "Primary Regulated Dual Power Supply", IBM Technical Disclosure Bulletin, Vol. 21, No. 10, March 1979m pp.4298-300.	
JZ		"5-W dc-dc converters aim at telecomm applications", Electronic Design Vol 31, No. 15, July 21, 1983 pp 227	
JZ		"Combined Switch-Mode Power Amplifier and Supply", IBM Technical Disclosure Bulletin, Vol. 28, No. 3, August 1985, pp. 1193-1195.	

Examiner Signature	Jeffrey Zweizig	Date Considered	12/11/00

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Complete if Known	
Application Number	New Application 09/573,081
Filing Date	Herewith 5/16/00
First Named Inventor	Balu Balakrishnan
Group Art Unit	
Examiner Name	
Attorney Docket Number	003592.P036D

Sheet 2 of 6

U.S. PATENT DOCUMENTS

Examiner Initials*		U.S. Patent Document Number	Name of Patentee or Applicant of Cited Document		Date of Publication of Cited Document MM-DD-YYYY	Filing Date if Appropriate
JZ		4,622,627	Rodriguez et al	363/37	11/11/1986	2/18/1984
JZ		4,695,936	Whittle	363/21	9/22/1987	2/7/1986
JZ		4,706,176	Kotlechau	363/21	11/10/1987	7/7/1986
JZ		4,706,177	Josephson	363/24	11/10/1987	11/14/1985
JZ		4,720,841	Faini	307/18	1/19/1988	1/19/1988
JZ		4,725,769	Cini et al	323/283	2/16/1988	4/9/1987
JZ		4,734,839	Barthold	363/16	3/29/1988	3/23/1987
JZ		4,739,462	Farnsworth et al	363/21	4/19/1988	12/20/1984
JZ		4,808,844	Claydon et al	323/311	2/21/1989	6/17/1988
JZ		4,809,148	Bam	363/26	2/28/1989	10/21/1987

FOREIGN PATENT DOCUMENTS

Examiner Initials*		Foreign Patent Document Office or Country	Number	Date	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation? Yes/No
JZ		EPO	EP 0 791 821 A1	1/2/1997			
JZ		EPO	EP 0 748 034 A1	12/11/1996			
JZ		EPO	EP 0 748 035 A1	12/11/1996			

OTHER DOCUMENTS

Examiner Initials*	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published (if known).	Translation? Yes/No
JZ	R. Bruckner, et al., "Optimizing Converter Design and Performance Utilizing Mixed Controller System Feedback Control", Proceedings of Powercon 8, E-2, 1981, pp 1-10	
JZ	B. Pelly et al., Of Power MOSFETs take the load off switching supply design", Electronic Design, February 1983, pp 135-139.	
JZ	D. Azzid et al, "Flyback on Card Power Supply", IBM Technical Disclosure Bulletin, Vol 23, No. 4, September 1980, pp. 1477-78	
JZ	A.J. Bowen et al., " Power Supply with Optical Isolator", IBM Technical Disclosure Bulletin Vol. 14, No. 11, April 1972, pp. 3320	

Examiner Signature	Jeffrey Zweizig	Date Considered	12/11/00

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Complete if Known	
Application Number	New Application 09/573,681
Filing Date	Herewith 9/14/00
First Named Inventor	Balu Balakrishnan
Group Art Unit	
Examiner Name	
Attorney Docket Number	003692.P036D

Sheet 3 of 8

U.S. PATENT DOCUMENTS

Examiner Initials *		U.S Patent Document Number	Name of Patentee or Applicant of Cited Document		Date of Publication of Cited Document MM-DD-YYYY	Filing Date if Appropriate
JZ		4,811,184	Kominsky et al	363/17	3/7/1989	5/10/1988
JZ		4,814,674	Hressley	318/354	3/12/1989	3/25/1987
JZ		4,858,094	Berlage	363/21	8/15/1989	10/18/1988
JZ		4,862,339	Inou et al	363/21	8/29/1989	3/31/1988
JZ		4,866,590	Ozaka et al	363/49	9/12/1989	7/28/1988
JZ		4,870,556	White	363/21	9/26/1989	10/14/1988
JZ		4,887,199	Whittle	363/49	12/12/1989	9/22/1987
JZ		4,888,497	Dallabora et al	307/272.3	12/19/1989	4/28/1988
JZ		4,890,210	Meyers	363/21	12/26/1989	11/15/1988
JZ		4,928,220	White	363/56	5/22/1990	10/14/1988

FOREIGN PATENT DOCUMENTS

Examiner Initials *		Foreign Patent Document Office or Country	Number	Date	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation? Yes/No

OTHER DOCUMENTS

Examiner Initials *		Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published (if known).	Translation? Yes/No
JZ		"Off-Line Power Supply Control Technique Using a Single Transformer to Feed Back Three Control Signals", IBM Technical Disclosure Bulletin, Vol. 32, No. 8A, January 1990, pp. 272-3	

Examiner Signature	Jeffrey Zweizig	Date Considered	12/11/00

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet 4 of 6

Complete if Known	
Application Number	New Application 09/573,081
Filing Date	Herewith 5/16/00
First Named Inventor	Balu Balakrishnan
Group Art Unit	
Examiner Name	
Attorney Docket Number	003692.P038D

U.S. PATENT DOCUMENTS

Examiner Initials*		U.S.Patent Document Number	Name of Patentee or Applicant of Cited Document		Date of Publication of Cited Document MM-DD-YYYY	Filing Date if Appropriate
JZ		4,937,728	Leonardi	363/97	6/26/1990	10/19/1989
JZ		4,943,907	Cardwell, Jr.	363/97	7/24/1990	7/24/1990
JZ		5,012,401	Berlekge	363/97	4/30/1991	3/19/1990
JZ		5,014,178	Balakrishnan	363/49	5/7/1991	5/14/1990
JZ		5,034,871	Okamoto et al	363/15	7/23/1991	3/25/1990
JZ		5,041,958	Marinus	363/21	8/20/1991	2/12/1990
JZ		5,072,353	Feldkeller	363/20	12/10/1991	10/1/1990
JZ		5,086,364	Leipold et al	361/18	2/4/1992	2/19/1991
JZ		5,146,394	Ishii et al	363/16	9/8/1992	6/22/1990
JZ		5,161,098	Balakrishnan	363/144	11/3/1992	9/3/1991

FOREIGN PATENT DOCUMENTS

Examiner Initials*		Foreign Patent Document Office or Country	Number	Date	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation? Yes/No

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Examiner Signature	Jeffrey Zweizig	Date Considered	12/4/00

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Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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Substitute for form 1449A/PTO
(Modified by SSTZ 9/30/99)

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Complete if Known	
Application Number	New Application 09/575,081
Filing Date	Herewith 5/11/00
First Named Inventor	Balu Balakrishnan
Group Art Unit	
Examiner Name	
Attorney Docket Number	003692.P036D

Sheet 5 of 8

U.S. PATENT DOCUMENTS

Examiner Initials*		U.S. Patent Document Number	Name of Patentee or Applicant of Cited Document		Date of Publication of Cited Document MM-DD-YYYY	Filing Date if Appropriate
JZ		5,177,408	Marques	315/291	7/19/1991	1/5/1993
JZ		5,200,888	Schwarz et al	363/49	4/6/1993	3/10/1992
JZ		5,297,014	Saito et al	363/21	4/5/1993	1/3/1992
JZ		5,313,381	Balakrishnan	363/147	5/17/1994	9/1/1992
JZ		5,394,017	Catano et al.	307/66	12/2/1992	2/28/1995
JZ		5,452,195	Lehr et al.	363/21	9/19/1995	10/6/1993
JZ		5,461,303	Leman et al.	323/222	10/24/1995	1/31/1994
JZ		5,481,178	Wilcox et al.	323/287	3/23/1996	1/2/1996
JZ		5,508,602	Borgato et al.	323/222	4/16/1996	9/28/1993
JZ		5,528,131	Marty et al.	323/901	6/18/1996	9/21/1993

FOREIGN PATENT DOCUMENTS

Examiner Initials*		Foreign Patent Document Office or Country	Number	Date	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation? Yes/No

OTHER DOCUMENTS

Examiner Initials*		Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published (if known).	Translation? Yes/No

Examiner Signature	Jeffrey Zweizig	Date Considered	12/11/00

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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PTO/SB/08A (10-00)
Approved for use through 10/31/02. OMB 0651-0031
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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Substitute for form 1449A/PTO (Modified by BSTZ 8/30/99)

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Complete if Known	
Application Number	New Application 09/573,081
Filing Date	Herewith 5/16/00
First Named Inventor	Balu Balakrishnan
Group Art Unit	
Examiner Name	
Attorney Docket Number	003692.P036D

Sheet 6 of 6

U.S. PATENT DOCUMENTS

Examiner Initials*		U.S. Patent Document Number	Name of Patentee or Applicant of Cited Document		Date of Publication of Cited Document MM-DD-YYYY	Filing Date if Appropriate
JZ		5,552,746	Danstrom	327/427	9/3/1996	4/7/1995
JZ		5,563,534	Rossi et al.	327/77	10/8/1996	5/9/1994
JZ		5,568,064	McClure et al.	327/538	10/22/1996	2/6/1994
JZ		5,570,057	Palara	327/369	10/29/1996	4/12/1995
JZ		5,572,156	Diazzi et al.	327/109	11/5/1996	9/18/1995
JZ		5,619,403	Ishikawa et al.	363/21	4/8/1997	7/20/1993
JZ		5,617,016	Borghi et al.	323/284	4/1/1997	10/20/1994
JZ		5,621,629	Hemminger et al.	363/58	4/15/1997	8/7/1995
JZ		5,640,317	Lai	363/49	6/15/1995	6/17/1997

FOREIGN PATENT DOCUMENTS

Examiner Initials*		Foreign Patent Document: Office or Country	Number	Date	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation? Yes/No

OTHER DOCUMENTS

Examiner Initials*		Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published (if known).	Translation? Yes/No

Examiner Signature	Jeffrey Zweizig	Date Considered	12/11/00

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

ATTACHMENT TO AND MODIFICATION OF NOTICE OF ALLOWABILITY (PTO-37)

(November, 2000)

NO EXTENSIONS OF TIME ARE PERMITTED TO FILE CORRECTED OR FORMAL DRAWINGS, OR A SUBSTITUTE OATH OR DECLARATION, notwithstanding any indication to the contrary in the attached Notice of Allowability (PTO-37).

If the following language appears on the attached Notice of Allowability, the portion lined through below is of no force and effect and is to be ignored[1]:

~~A SHORTENED STATUTORY PERIOD FOR RESPONSE to comply with the requirements noted below is set to EXPIRE THREE MONTHS FROM THE "DATE MAILED" of this Office action. Failure to comply will result in ABANDONMENT of this application. Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).~~

Similar language appearing in any attachments to the Notice of Allowability, such as in an Examiner's Amendment/Comment or in a Notice of Draftperson's Patent Drawing Review, PTO-948, is also to be ignored.

[1] The language which is crossed out is contrary to amended 37 CFR 1.85(c) and 1.136. See "*Changes to Implement the Patent Business Goals*", 65 *Fed. Reg.* 54603, 54629, 54641, 54678, 54674 (September 8, 2000), 1238 *Off. Gaz. Pat. Office* 77, 99, 110, 135, 139 (September 19, 2000).

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

NOTICE OF ALLOWANCE AND ISSUE FEE DUE

HM92/1213

JAMES Y SO
BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP
12400 WILSHIRE BOULEVARD
SEVENTH FLOOR
LOS ANGELES CA 90025-1026

APPLICATION NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT		DATE MAILED
09/573,081	05/16/00	019	ZWEIZIG, J	2816	12/13/00
First Named Applicant	BALAKRISHNAN,	35 USC 154(b) term ext. =	0 Days.		

TITLE OF INVENTION: OFF-LINE CONVERTER WITH INTEGRATED SOFTSTART AND FREQUENCY JITTER

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
3 003692.P036D	327-172.000	HM1	UTILITY	NO	$1240.00	03/13/01

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED.

THE ISSUE FEE MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED.

HOW TO RESPOND TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

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B. If the status is the same, pay the FEE DUE shown above.

If the SMALL ENTITY is shown as NO:

A. Pay FEE DUE shown above, or

B. File verified statement of Small Entity Status before, or with, payment of 1/2 the FEE DUE shown above.

II. Part B-Issue Fee Transmittal should be completed and returned to the Patent and Trademark Office (PTO) with your ISSUE FEE. Even if the ISSUE FEE has already been paid by charge to deposit account, Part B Issue Fee Transmittal should be completed and returned. If you are charging the ISSUE FEE to your deposit account, section "4b" of Part B-Issue Fee Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give application number and batch number.
Please direct all communications prior to issuance to Box ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

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5

#5 IDS B

Docket No.: 003692.P036D

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application for:

Balakrishnan et al.

Application No.: 09/573,081

Filed: May 16, 2000

For: OFF-LINE CONVERTER WITH INTEGRATED SOFTSTART AND FREQUENCY JITTER

OIPE JAN 12 2001 PATENT & TRADEMARK OFFICE

Examiner:

Art Group:

Batch No:

TRANSMITTAL OF FORMAL DRAWINGS

Attn: Official Draftsman
Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Enclosed herewith for filing in the above-identified U.S. patent application are the formal drawings, Figures 1, 2, 3, 4, 5, 6, 7, 8 and 9 (9) sheets.

Respectfully submitted,

BLAKELY SOKOLOFF TAYLOR & ZAFMAN, LLP

Date: 1/5/01

James Y. Go
Reg. No. 40,621

12400 Wilshire Boulevard
Seventh Floor
Los Angeles, CA 90025
(425) 827-8600

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231, on January 5, 2001

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Signature

01-05-01

Date

6229366

1/9

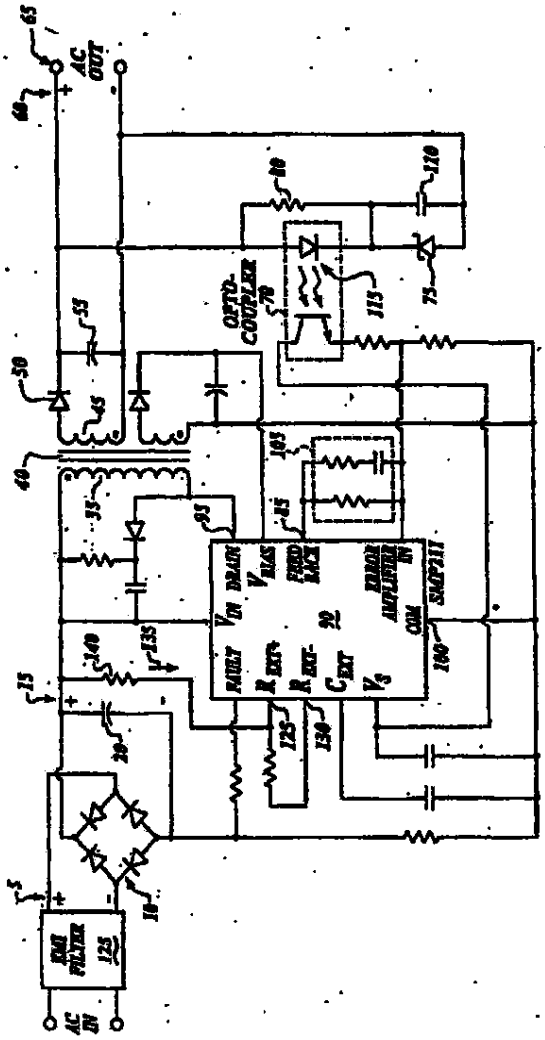


Fig. 1 (PRIOR ART)

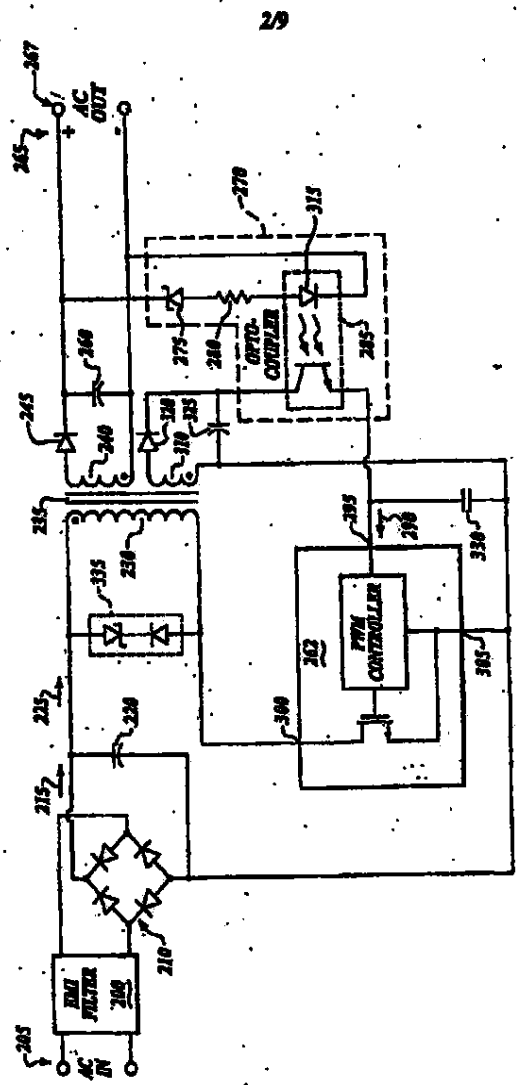
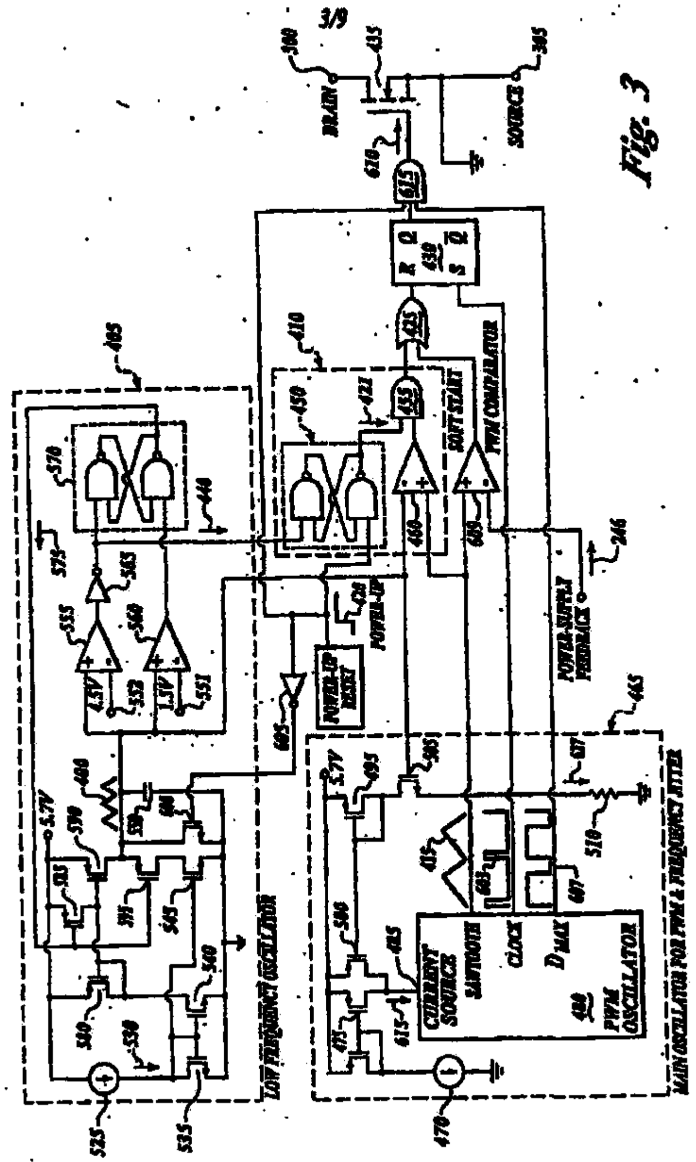


Fig. 2

3/9


DRAIN
SOURCE
SOFT START
PWM COMPARATOR
POWER-UP
POWER-UP RESET
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CLOCK
PWM OSCILLATOR
LOW FREQUENCY OSCILLATOR
MAIN OSCILLATOR FOR PWM & FREQUENCY JITTER

Fig. 3

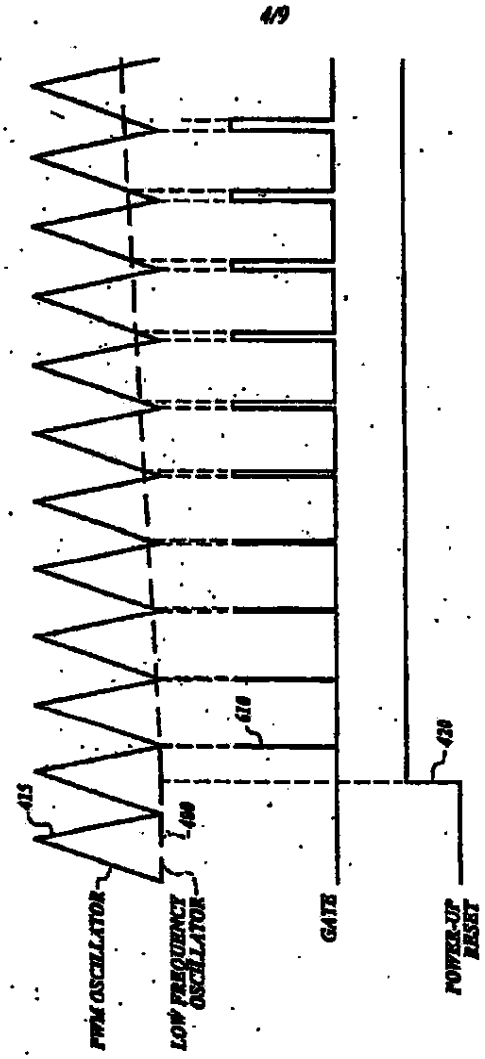

4/9
415
410
420
PWM OSCILLATOR
LOW FREQUENCY OSCILLATOR
GATE
POWER-UP RESET

Fig. 4

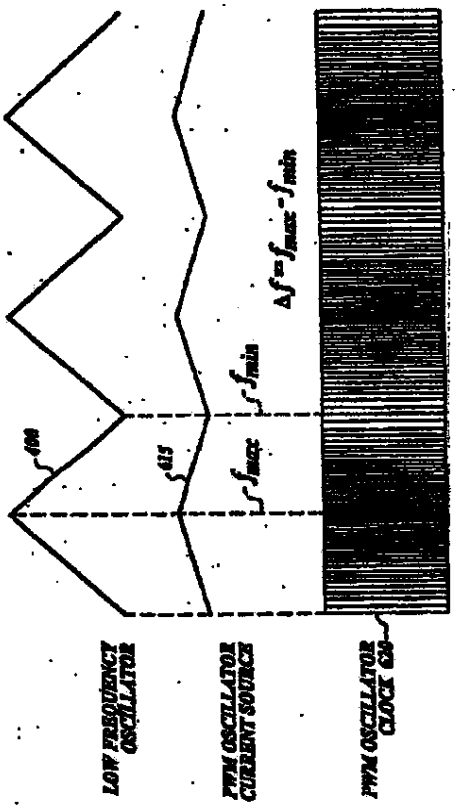

LOW FREQUENCY OSCILLATOR
PWM OSCILLATOR CURRENT SOURCE
PWM OSCILLATOR CLOCK 620
610
615
f_{min}
f_{max}
$\Delta f = f_{max} - f_{min}$

Fig. 5

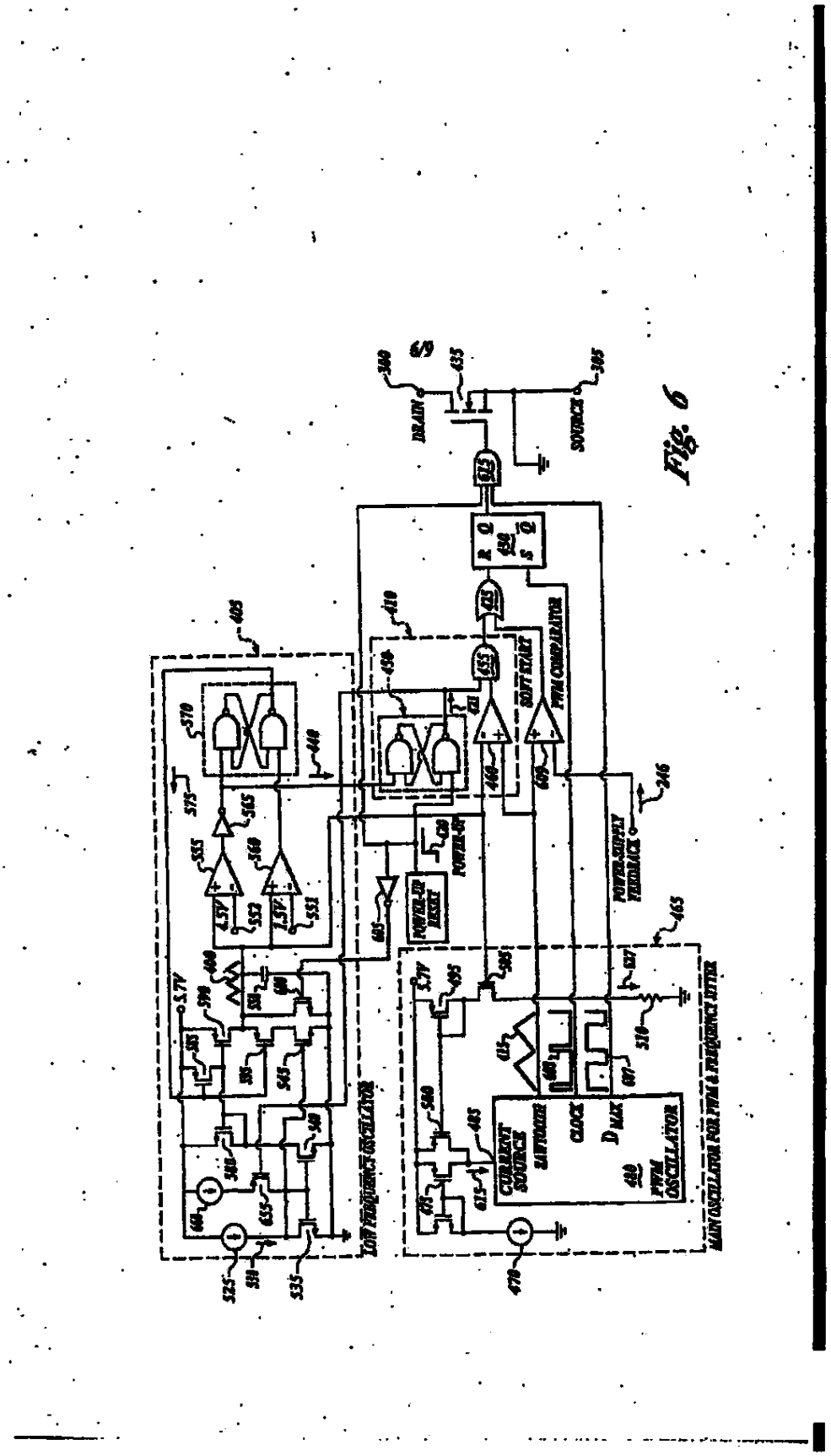

DRAIN
SOURCE
SOFT START
PWM COMPARATOR
POWER-UP RESET
POWER-SUPPLY FEEDBACK
CURRENT SOURCE
CLOCK
PWM OSCILLATOR
LOW FREQUENCY OSCILLATOR
MAIN OSCILLATOR FOR PWM & FREQUENCY JITTER

Fig. 6

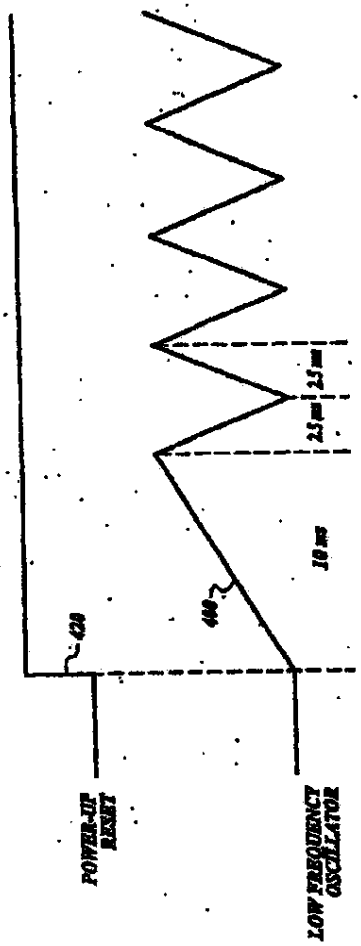

2.5 ms
2.5 ms
10 ms
440
420
POWER-UP RESET
LOW FREQUENCY OSCILLATOR

Fig. 7

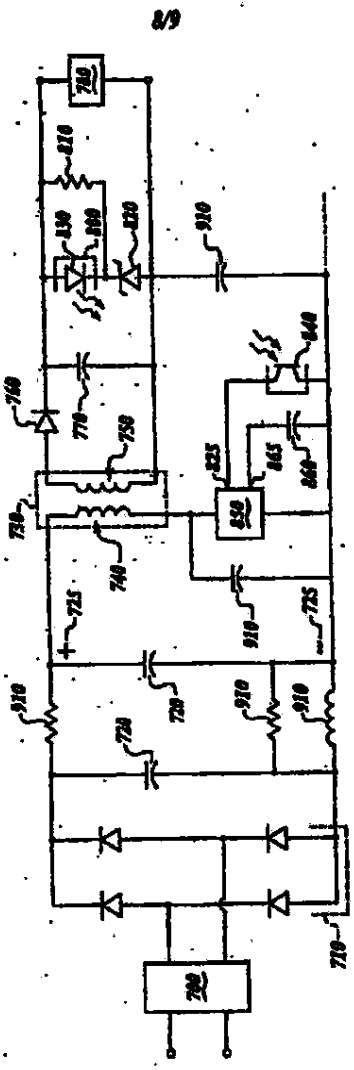


Fig. 8

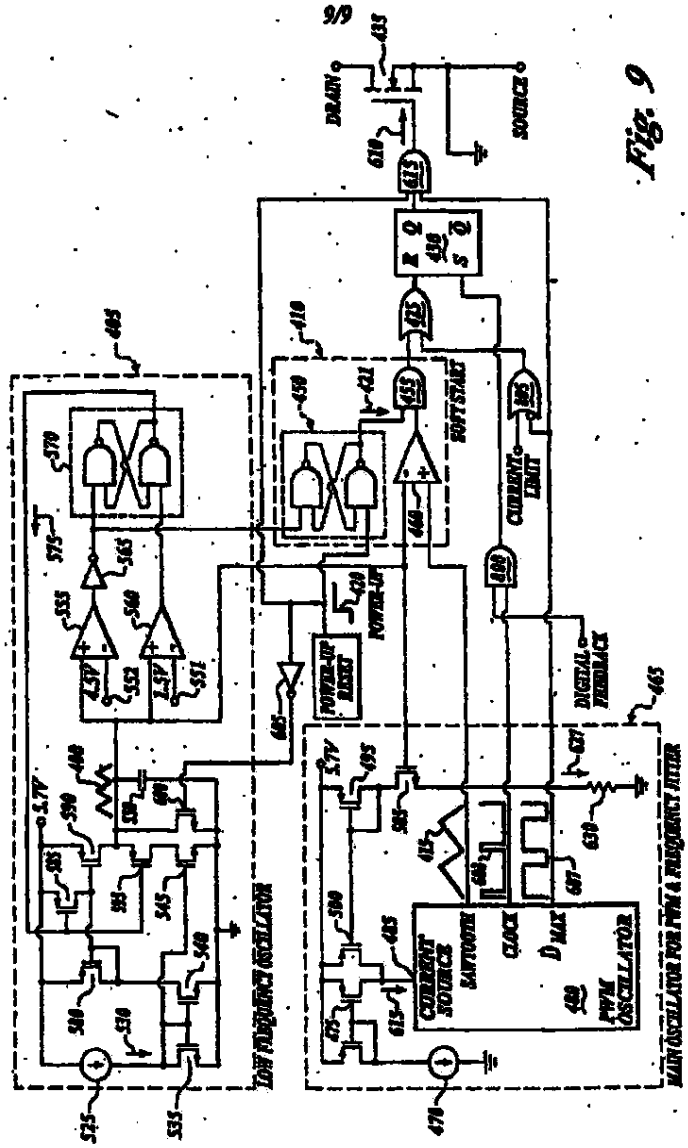
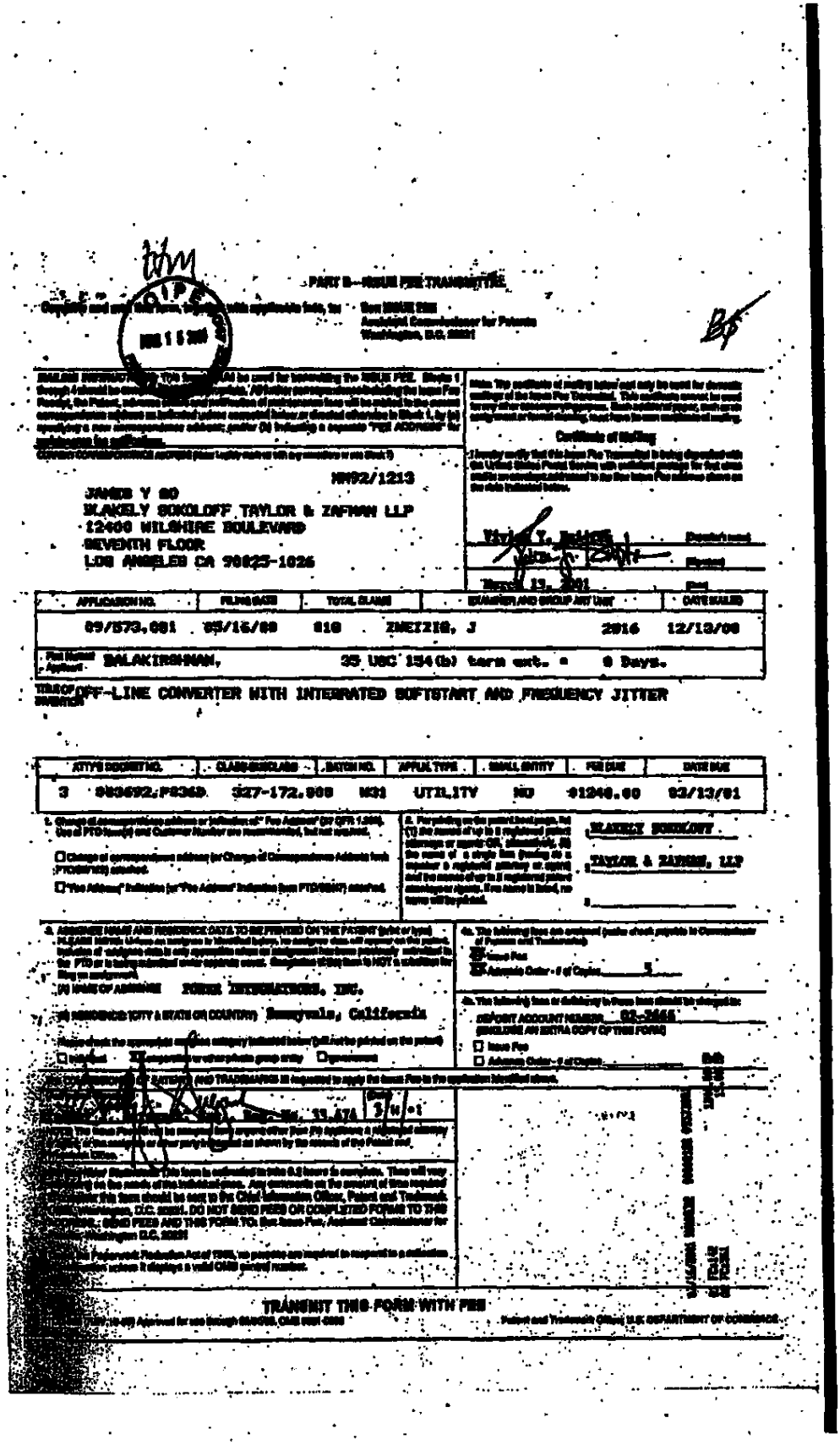

9/9
DRAIN
SOURCE
CURRENT LIMIT
DIGITAL FEEDBACK
CLOCK
CURRENT SOURCE
SAWTOOTH
PWM OSCILLATOR

Fig. 9



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First Named Applicant: BALAKRISHNAN,

35 USC 154(b) term ext. = 0 Days.

TITLE OF INVENTION: OFF-LINE CONVERTER WITH INTEGRATED SOFTSTART AND FREQUENCY JITTER

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BLAKELY SOKOLOFF
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